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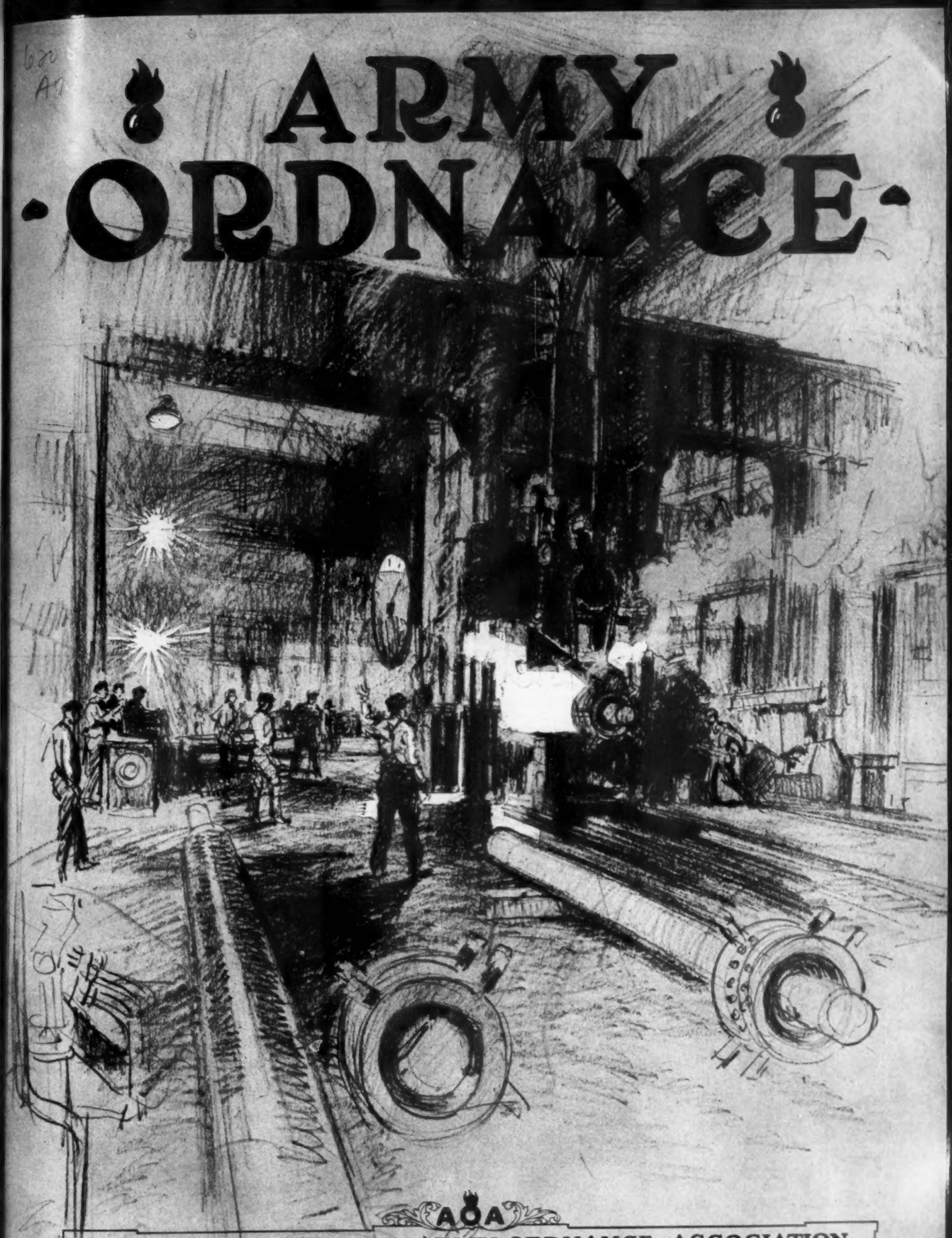

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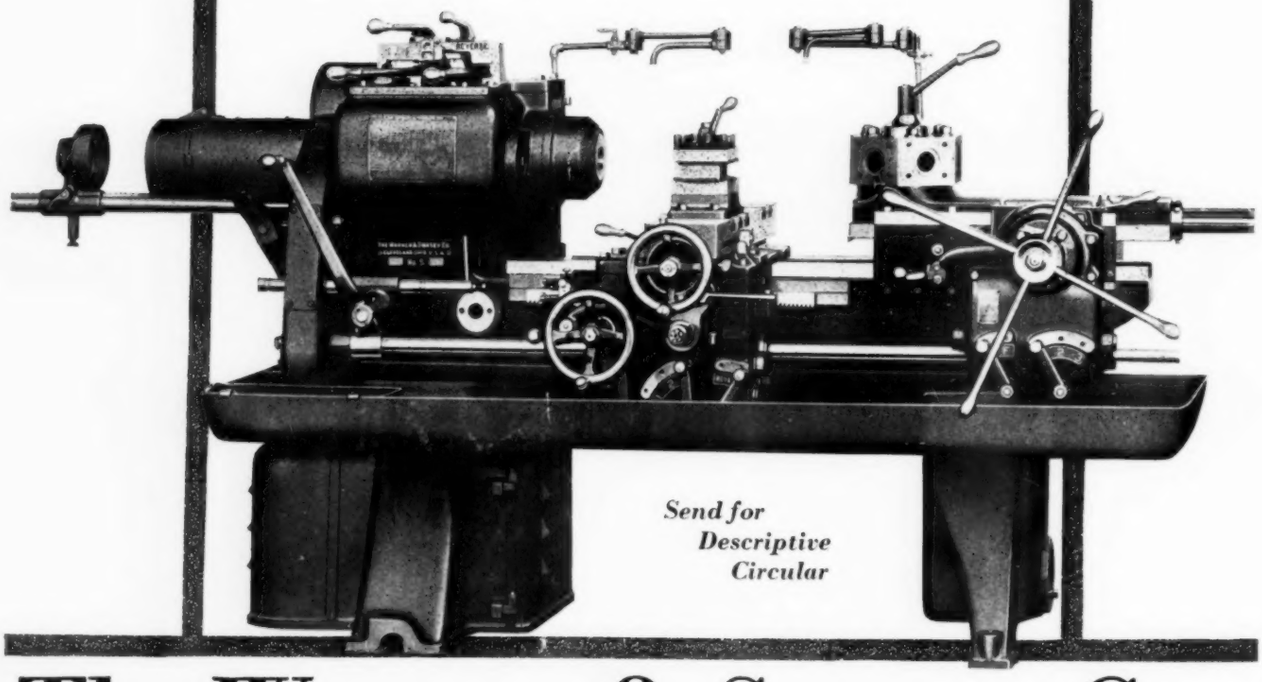

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ARMY ORDNANCE

The Journal of the Army Ordnance Association

Pledged to Public Service in Effecting Industrial Preparedness for War as Our Strongest Guarantee of Peace

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"The nation that hopes to be prepared for future emergencies must make certain that its preparations for defense include plans for the rapid and efficient transformation of its peace power into war power. War has entered the field of the exact sciences and every advance of chemistry, physics, and mechanics demands investigation and adoption."—*James W. Good, Late Secretary of War.*

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THE Army Ordnance Association is a national organization of American citizens pledged to industrial preparedness for war as our Nation's strongest guarantee of peace.

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To commemorate the services rendered by the Industry of the Nation and by the Officers and Civilian Employees of the Ordnance Department in the wars in which the United States has been engaged.

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America's Latest Coast Defense Gun on Railway Carriage

ARMY ORDNANCE

VOL. X JANUARY-FEBRUARY, 1930 No. 58

Railway Artillery

Its Evolution and Use and a Description of Post-War Types

By G. M. Wells*

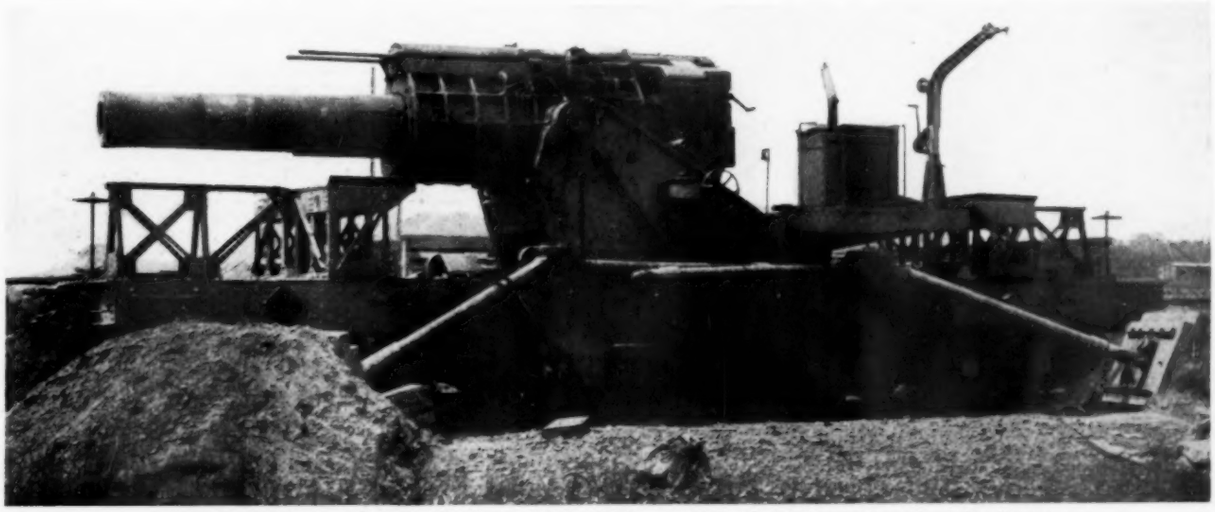
ANY plan for the military defense of the United States must be predicated on our peculiar geographical situation; in other words, upon the great length and the consequent difficulty of defending our four frontiers, Atlantic, Pacific, Canadian and Mexican, against an invading force. The first requirement in any defense plan is, of course, a strong navy. Of almost equal importance is the provision of coast defense fortifications for our principal harbors of such strength as to afford a safe refuge and base for our own ships and to promise certain destruction of any enemy ship that tries to enter. The need for heavy artillery defense of the open coast line is of questionable, and in any case, secondary importance. Favorable landing places on the open beach are few and the difficulties in establishing and maintaining a base are many. For these reasons adequate defense of the entire frontier does not appear to offer insurmountable difficulties.

How does the railway artillery fit into our national defense plan? What are its peculiar advantages and limitations? What progress have we made in perfecting suitable types? The first two questions pertain to tactics and are, therefore, somewhat outside the scope of this article. They will be summarized in a few words representing the generally accepted school of military thought on the subject, modified to some extent perhaps by the personal opinions of the writer.

Railway artillery will fill two distinct roles: (1) Defense against rapidly moving targets presented by naval vessels in coast defense; and (2) Long range fire against fixed targets as an adjunct to the field army.

IN fulfilling the first role railway artillery will be used to supplement the fixed coast defenses of important harbors, and further, to provide the primary protection of less important harbors, where for economic reasons the fixed armament has been held to the minimum. Railway artillery may also be used to some extent to protect points along the open coast line against threatened landings of the enemy in force. This latter use, however, may assume exaggerated importance in the public mind. Railroad lines parallel to the beach is a popular and pleasing, but entirely fallacious, conception. The cost would be enormous and entirely out of keeping with the results to be obtained. Short spur lines to important points along the shore are what we need and all we can expect to have. The value of railway artillery as an adjunct to the field army is obvious and requires no discussion.

The advantages claimed for railway artillery are: (1) A mount can be moved from place to place and made to fulfill the functions of several of the fixed type with a consequent reduction in the initial construction and the subsequent maintenance costs of the defense system; (2) It can be withdrawn to prevent capture and relocated to prevent further advance of the enemy inland; and (3) The highly



12-Inch Howitzer Railway Carriage, 1918. Note amount of earth used as float backings.

*Chief, Railway and Harbor Defense Carriage Section, Artillery Division, Office of the Chief of Ordnance, Washington, D. C. Captain, Ordnance Department, U. S. Army.

America's Latest Coast Defense Gun on Railway Carriage

developed railway system of this country facilitates the use of railway artillery.

The principal objections advanced against railway artillery are: (1) Major caliber guns, so mounted, are limited to a few degrees of traverse on the mount, and elaborate platforms of a semipermanent nature must be provided at predetermined points for use in wide-traverse fire against moving naval targets; (2) Considerable time is required to emplace the mount and prepare it for firing; and (3) The rate of fire is slow.

8-Inch Gun on Railway Mount, Model 1920, at 0° Elevation.

These objections apply only, and then in a very limited degree, to the very largest railway gun mounts. The improved post-war types have been designed with a view to rapid emplacement and a rate of fire and an ease of handling comparable to a heavy fixed gun.

After weighing the conflicting factors we may safely conclude that there is a very real need for railway armament and that conditions in this country are especially favorable to its employment. Let us regard it then as the connecting link between the highly mobile artillery of minor calibers accompanying a field army and guns of the heaviest type on fixed emplacements installed for service against naval targets and as a protection of our more important harbors and naval stations.

BEFORE taking up the discussion of post-war types it will be of interest to trace very briefly the evolution of this class of armament from its inception to the end of the World War, and to point out in what way the lessons learned from the early types have been applied in our post-war development program.

The first railway mount of which there is any record was built by the Confederate Army, and used in 1862 in one of the "Seven Days' Battles" east of Richmond. It consisted of a 32-pounder muzzle-loading mortar mounted on a flat car. Credit for conception of the idea of constructing such a carriage is generally given to Gen. Robert E. Lee. Later in the war the Union Army made some use of railway mounts similar to the original Confederate design.

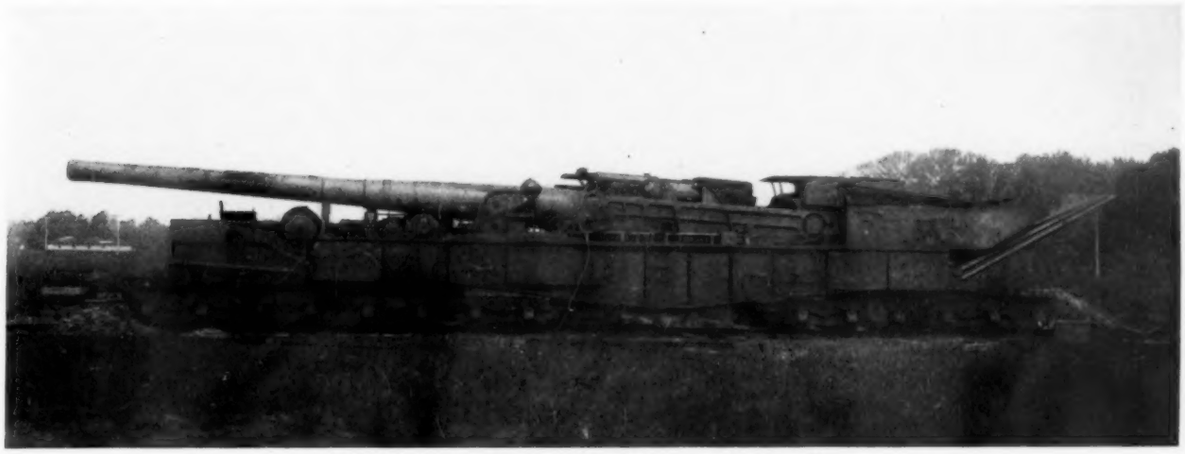
Gen. Joseph E. Brent, an officer of the Confederate Army who had served with the railway mortars, visited France about 1870 and discussed with Napoleon III a plan for fortifying inland cities by means of railway gun mounts. The French Staff was not at first particularly impressed with the idea and thirteen years elapsed before interest developed to the point of experimenting with a 155-mm. howitzer on a railway car. Later French developments included a 120-mm. disappearing gun carriage on railway wheels for coast defense purposes, a number of which were purchased by the Danish Government, and several 200-mm. howitzer mounts for the Peruvian Government. The latter carriage is supposed to represent the limit of development prior to 1914, although there is evidence to indicate that some of the German 42-cm. mortars used in the invasion of Belgium were mounted on railway cars.

The British interest in this class of matériel lagged behind the French and little was accomplished prior to the World War in the development of satisfactory railway gun carriages. A few 4.7-inch guns mounted on hastily improvised railway flat cars were used during the Boer War, notably during the Campaign for the Relief of Ladysmith. Nothing had been done in our own services prior to 1914. In fact, railway artillery does not seem to have been recognized as an important and separate subdivision of artillery before the outbreak of the World War.

THE requirements of the World War furnished the necessary incentive for the rapid development of major caliber mobile artillery. The World War early developed into a conflict of fixed positions with the lines between the combatants practically stationary. Each side desired to reach farther and farther to the rear of the opposing lines to strike at vital points in the communication and supply systems. This called for the use of major caliber guns.

The naval superiority of the Allies and the extensive use of mines and submarines removed the need for extensive harbor defense armament and a considerable supply of major caliber cannon was therefore available. The only problem then was to supply suitable mobile carriages for utilizing these guns in field operations. The railway carriage was quite evidently the most promising

8-Inch Gun on Railway Mount, Model 1920, at 52° Elevation.



14-Inch Gun on Railway Mount in Traveling Position.

means available for mounting and transporting the heavy guns, while the special conditions of a warfare of fixed positions were favorable to a rapid and relatively inexpensive improvization of suitable mounts from existing matériel. For example, since a gun would be used against only one or at the most a very limited number of targets during a particular operation, it was unnecessary to provide for more than the few degrees of traverse necessary in adjusting the fire, and the time required for preparing the mount for firing and the subsequent rate of fire were not of very great importance. It is important to note that these conditions are diametrically opposed to the essential requirements of seacoast armament.

The great variety both in caliber and design of the guns available effectively precluded a standardized type of mount, nor was any particular effort made to develop a uniform design. Major caliber guns were urgently required and the principal object of the manufacturing program seems to have been to supply, regardless of uniformity, the greatest number of acceptable carriages in the shortest possible time. As a result, a casual scrutiny of the war-time matériel appears to indicate a considerable variety in the basic designs, with some very interesting and novel features in particular mounts. For example, we find carriages entirely lacking in recoil and counter-recoil systems, carriages without any traversing mechanism, and finally guns operated in counter-recoil by sheaves of rubber bands.

IT is possible by considering only the essential features to group the war-time railway matériel in three general classes descriptive of the method used in absorbing the shock of recoil, and from this division to determine its utility as a means of seacoast defense against naval targets.

Sliding Mount. The most successful mounts of this type have the gun mounted with its trunnions directly connected to the girders of the railway carriage. The entire shock of recoil is absorbed by the frictional resistance of the mount sliding to the rear on a specially prepared firing platform. There is no traversing mechanism in the mount and the gun is pointed by moving the carriage on its own wheels to the proper position on a curved track, or epi. The mount must be returned to its original position on the track after each shot. The time required for preparing the firing position is from two to three days and the maximum rate of fire is about one shot every three minutes.

Rolling Mount. The gun is mounted in a cradle recoil mechanism which supplies a part of the firing reaction, the remainder being accounted for by the carriage rolling to the rear on its own wheels. The necessary traverse is in part obtained from a small movement of the top carriage with respect to the main girders and in part from movement of the mount along the curved track. The elevation is limited to about 15°, considerably less than that required to develop the full range of the gun. The time required for preparing the firing track is from one to three days and the maximum rate of fire about one shot every three minutes.

Platform Mount. In this type of design the gun is mounted in a cradle recoil mechanism which absorbs a considerable part of the recoil energy, the remainer being transmitted to the ground through a firing platform and outriggers. The traverse may be obtained by movement between the trucks and main girders, or between a top carriage and main girder or by a base ring and rollers. The total angular traverse varies from about 5° in the first type to a possible 360° in the last. The time required for in-

14-Inch Gun on Railway Mount at 15° Elevation, Maximum Left Traverse.

stalling the firing platform varies from three to four hours for the lighter carriages to several days for the heaviest mounts. A rate of fire of one shot per minute is obtainable with the medium calibers.

It is very apparent that matériel in the first two groups is entirely unsatisfactory for use against moving naval targets. The restrictions both as to rapidity and amount of traverse, the limited angular elevation of guns in certain mounts, the low rate of fire and the excessive time required for preparing the firing positions preclude their being used for anything but land warfare. There has been some discussion since the war regarding the feasibility of using the sliding mounts on heavy turntables permanently located at predetermined positions along the coast, but there is doubt concerning whether or not the mounts are sturdy enough to take the shock of recoil if held rigidly to a foundation. In any event, it is doubtful whether such action would be justifiable for economic reasons. We may conclude that the platform mount permitting 360° traverse is the only all-purpose type developed during the war and the one on which our post-war development should be patterned.

All of the foregoing types had been developed by our Allies prior to the entry of the United States into the war. All were reasonably satisfactory in a warfare of fixed positions. It has been stated that time did not permit of development through the slow process of evolution but rather that it was carried on under the stress of a desperate need for matériel for a specific purpose. Therefore, the possible future use of the matériel for seacoast purposes could not be satisfactorily provided for at that time.

THE status of railway artillery development in this country at the time of our entry into the World War may be sketched in a few words. Four 4.7-inch howitzers mounted on railway carriages of the platform type were completed early in 1917 for service in Panama. Designs covering 14-inch gun and 16-inch howitzer railway mounts were begun in 1915 and finished shortly before the United States declared war in 1917. One unit of each type was constructed during the war and tested after the Armistice. Both designs were completed before our ordnance engineers had had the opportunity to study European designs or learn much from the practical lessons of war experience. It is, therefore, very gratifying that these designs, especially the 14-inch carriage, embodied features which were considered quite admirable and indicated considerable progress as early as the close of the war.

Our war-time production program of railway matériel

14-Inch Gun on Railway Mount at 50° Elevation.

was divided between the construction of several models of French design adapted to our methods of manufacture and our own guns, and original designs intended to utilize not only existing guns and recoil mechanisms but, in certain cases, the barbette carriages as well. Included in the former category are 10-inch and 12-inch sliding mounts of a standard French design and a 12-inch mount of the platform type termed the "Batignolles." In the latter class we find 7-inch and 8-inch guns and a 12-inch mortar on railway barbette mountings permitting high angles of elevation and 360° traverse. The Navy Department, proceeding independently of the Army, designed and built several combination rolling platform mounts for their own 14-inch guns and delivered them in France several months before the Armistice. The Army manufacturing programs were carried forward as rapidly as possible with the full coöperation of our Allies. In certain instances guns were shipped to France for installation on carriages built in that country. In other cases parts were manufactured in the United States and shipped abroad for assembly. Large contracts were placed with car and locomotive builders in this country calling for the construction of complete units. Everything possible was done to speed up production, but the time was too short and only a small part of the matériel on order was completed before the Armistice. A very small percentage saw service in France. Part of the un-

completed contracts were cancelled shortly after the Armistice—others, further advanced, were carried to completion. The net result was a considerable quantity of railway matériel of more or less doubtful future utility.

Let us now attempt to analyze these war-time stocks in the light of our present day requirements and endeavor to decide what use can be made of them. The 10-inch and 12-inch sliding mounts are of no value for seacoast purposes and can only be used in the event an invading force succeeds in establishing itself in this country. The same decision holds for the 12-inch Batignolles although there is some possibility that we may use this mount on fixed emplacements for seacoast defense. The 14-inch Navy mounts cannot be used against moving targets on account of limited traverse. The 16-inch howitzer is unsatisfactory by reason of its limited range, the very cumbersome firing platform required and numerous mechanical difficulties. The same objections apply in a lesser degree to the 14-inch mount designed before the war. There are left then only the 8-inch gun and the 12-inch mortar platform mounts designed and manufactured in this country. Both are mounted on base rings and rollers and are capable of 360° traverse and adequate elevation. The system of anchorage, consisting of a simple track platform and outriggers, is very satisfactory and probably superior to any other developed during the war. The rate of fire is equal to similar guns on fixed carriages. A few mechanical defects exist which can be corrected. We may conclude then that these mounts will be reasonably satisfactory for any mission within the limited ranges of the cannon.

14-Inch Gun on Railway Mount on Permanent Emplacement 50° Elevation.

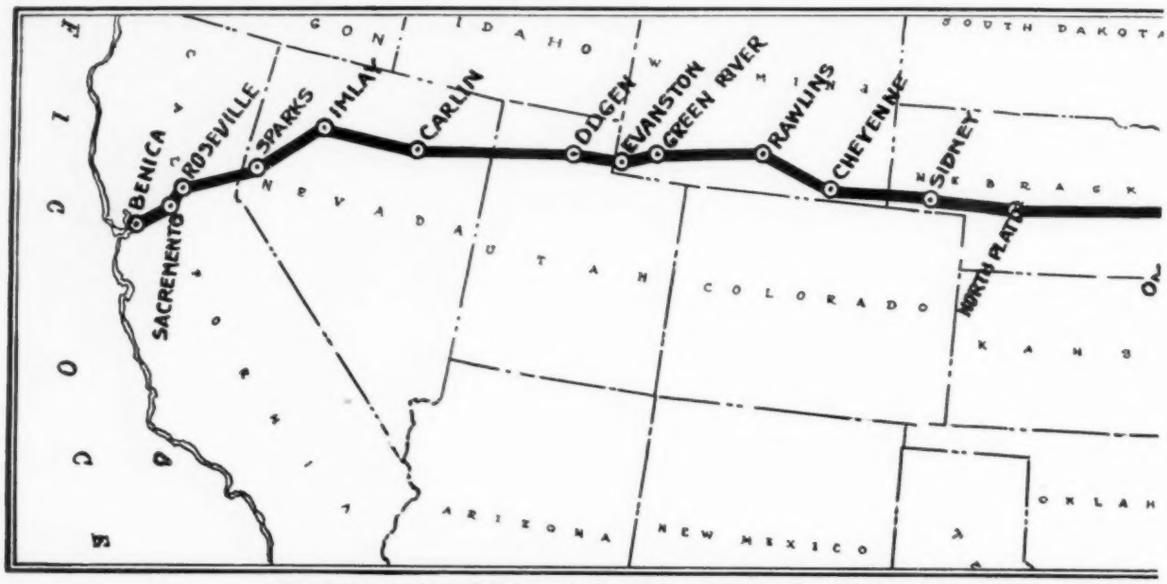
IN the post-war development of railway artillery the recommendations of the Caliber Board have been closely followed. Most readers will recall that this board was convened by order of the War Department shortly after the Armistice to make a study of the armament, calibers and types of matériel, kinds of ammunition, and methods of transportation of all the artillery to be assigned to a field army. The recommendations of the board relative to railway artillery are, in part:

"* * * four calibers (should be provided); an 8-inch gun with all around fire, a maximum range of 35,000 yards * * *; a 14-inch gun with a range of 40,000 yards and limited traverse; a howitzer of about 12-inch caliber, with a range of not less than 25,000 yards and a 360° traverse, and a 16-inch howitzer having a maximum range of not less than 27,000 yards and limited traverse. * * * It is essential that the seacoast problem be considered, since this type of artillery should be suitable not only for use in the field, but also for use along our coast against naval targets. For this reason, all carriages should be provided with means of obtaining all-around fire, either from a position previously prepared, or from a temporary platform. This feature of all-around fire in the case of large guns and howitzers will doubtless be in addition to the regular means provided for firing the mount in the field against a stationary target."

In interpreting these ideal requirements the Ordnance Department decided to furnish two dual purpose mounts; the first mounting interchangeably a high-powered 8-inch gun or 12-inch howitzer, and the second a 14-inch gun or 16-howitzer. The essential characteristics of each carriage were: elevation sufficient to develop the maximum range of the gun and to give high-angle fire for the howitzer; 360° traverse; a rate of fire of one shot per minute or less; the simplest and most efficient means for emplacement, preferably self-contained; adequate auxiliary equipment for transporting and serving ammunition and finally fire-control instruments for directing the fire accurately on either fixed or moving targets. The succeeding paragraphs will be devoted to a description of the matériel designed in accordance with these ideal requirements.

THE history of the lighter mount actually antedates the publishing of the Caliber Board requirements, the design having been started shortly before the Armistice in response to a request from the American Expeditionary Forces in France for a long range 12-inch mortar mounted on a carriage of the platform type giving wide traverse. The design, which was completed after the Armistice, appeared to incorporate so many desirable features and to be so superior to types on hand, that it was decided to proceed at once with the construction of a pilot. This action was entirely justified by the subsequent publication of the Caliber Board's conception of an ideal mount having nearly identical characteristics. Even in the light of nearly eleven years' post-war experience it appears probable that this carriage represents the limit of the ability of the designer to combine in one mount high and low-angle fire, all-around traverse and self-contained emplacing facilities which enable the mount to be emplaced for action on any standard track in less than an hour.

The carriage was originally designed for a 12-inch 20 caliber howitzer, but has since been found to be equally satisfactory for mounting the 8-inch 45 caliber navy gun, a considerable supply of which became available to the

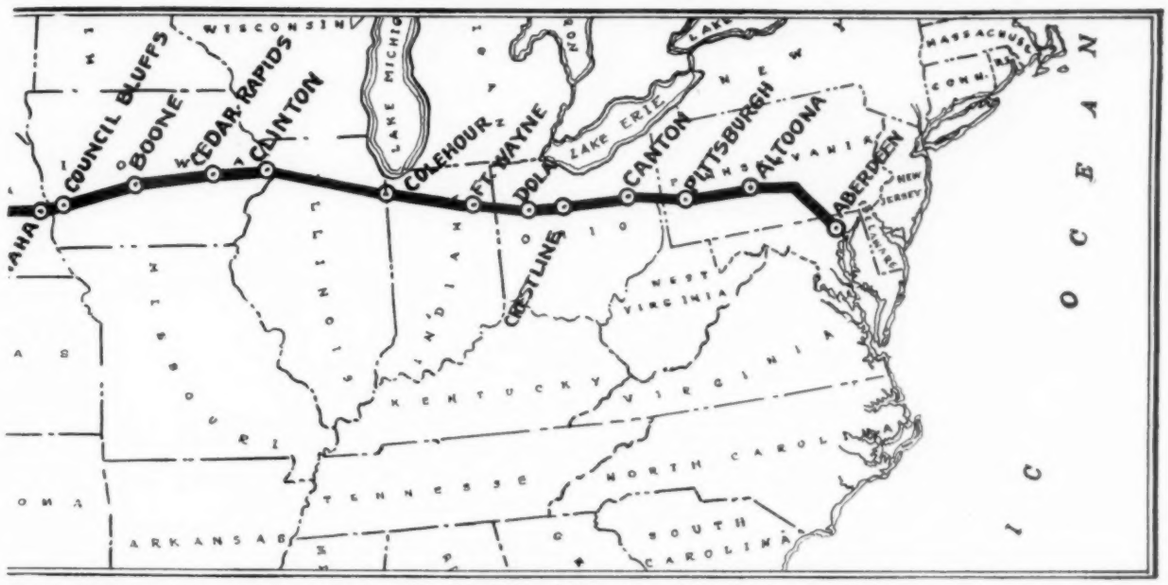


The Transcontinental Route of the "Coast Defense Gun Special" 14-inch Gun on Railway

Army as a result of the Disarmament Conference of 1921. The range of the howitzer is about 25,000 yards and of the gun, 35,000 yards. Special tipping parts, incorporating a cradle recoil mechanism of the latest hydropneumatic type for seacoast artillery, are supplied for each type of cannon. The mounting consists of a typical seacoast barbette carriage carried on a railway car with the base ring of the carriage forming an integral part of the frame of the car. The frame is depressed at the center between the trucks to lower the center of gravity as much as possible. The elevating gear is the most efficient type known, consisting of a train of spur gears with a band brake for controlling the kick-down. The gun and top carriage may be traversed 360° on the base ring. Both the elevating and traversing mechanisms are so efficient that one man can operate either without difficulty. To emplace the mount for firing it is first raised slightly from the trucks by means of built-in jacks. Then two steel I-beams are placed under the mount parallel to the rails and resting on the ties directly beneath the main girders. The carriage is next lowered by means of the jacks until the entire weight rests on the I-beams. The outriggers attached to the carriage are then set against wooden floats buried in the ground. The arrangement of the outriggers is such as to take the recoil thrust in whatever direction the gun may be pointed. Although the mount is hand maneuvered throughout, it is possible for a well trained crew to emplace it for firing in less than one hour and thereafter to fire at a rate of one shot per minute. Extensive tests conducted at Aberdeen Proving Ground have proved that when firing with the gun the mount is perfectly stable at all angles of elevation; with the howitzer, it is somewhat unstable at the lower angles, a defect which can be corrected quite readily by slight changes in the outrigger arrangement.

The 14-inch gun—16-inch howitzer railway mount is strictly a post-war development, the design having been started after the Armistice and carried out under the Caliber Board directive. The construction of the pilot carriage was completed in 1924 and since that year three additional mounts have been built and issued to the service. The design of a large mount of this type presents obvious difficulties. When we consider that the howitzer weighs nearly 200,000 lbs. and the gun somewhat more, and further that reasonable mobility, a high rate of fire and under certain conditions 360° traverse are essential, it is quite apparent that it will be impossible to retain the simplicity of design which characterizes the lighter post-war mount. Thus we find it necessary to supply two types of firing platforms, the first a relatively simple affair for use in land operations against fixed objectives, and the second a more elaborate construction of a permanent nature for use along the seacoast. Electric power motors combined with the flexible control provided by hydraulic speed gears are desirable for expediting the heavy work of emplacing and maneuvering the mount. In every case the power installations must be supplemented by an efficient system of manual control. A self-contained gas electric generating unit must accompany the mount. These features, however undesirable from a maintenance standpoint, are fully justified by the obvious advantages of a mobile weapon comparable in fire power to the heaviest fixed armament.

The carriage mounts interchangeably a 16-inch-25 caliber howitzer having a range of 30,000 yards or a 14-inch-50 caliber gun with a range of 40,000 yards. Special tipping parts incorporating a recoil cradle and hydropneumatic recoil mechanism are provided for each cannon. The recoil cradle is trunnioned in a top carriage which is in turn pivoted to a universal joint on the main car girders so as to permit its being raised to its firing position and lowered to the travelling position and also to permit traversing right or left 3½°. The top carriage is raised to firing position by two screws operated through gearing by an electric motor on the front deck of the car, or they may be operated by hand. When it has been raised the desired amount a cross beam is translated by hand gearing under the front of the top carriage and the screws lowered out of the way. The beam then transmits the weight and firing stresses. The lifting of the top carriage removes the neces-



Mount with Full Equipment from Aberdeen Proving Ground, Md., to Benicia, Calif., July, 1929.

sity for digging a pit for the gun to recoil into; it is an unique and very desirable feature. The gun is traversed on the top carriage around the universal joint by hand through a set of gearing. This limited traverse is utilized in land warfare in connection with the field platform. The elevating mechanism is of the ordinary seacoast type, either hand or power operated.

The field platform is very similar to that supplied for the 8-inch mount. Steel I-beams are laid on the track under each main girder and the mount lowered thereon by means of built-in jacks. Outriggers are used to transmit the horizontal and a part of the vertical firing stresses to the ground. As a part of the weight is still supported by the trucks it is necessary to insert wedges between the journal boxes and the lower part of the truck side frames to prevent undue vibration of the springs in firing. A well trained crew can install the mount on this emplacement in about an hour.

For seacoast work a number of permanent emplacements, consisting of a steel ring fastened to a concrete foundation with a central bedplate and bolts for securing the pintle, are prepared in advance at strategic points along the shore line. The mount is hauled into position over the emplacement and lowered by means of the jacks until the pintle rests on its bed plate and two traversing rollers, journaled in a transom between the girders, rest on the base ring. The trucks are then free to be withdrawn from under the two ends of the carriage. In this position the greater portion of the weight is carried on a ball traversing bearing in the pintle. Traverse through 360° may be accomplished by hand or motor power through gearing engaging the traversing rollers.

Two loading cranes are provided for raising the ammunition from the ground and placing it on the loading tray on the car platform in rear of the breech. This tray has a slope of minus 7° so that the projectile when started seats itself by force of gravity. The powder charges must be rammed into the chamber by hand. The breech block is of the Navy drop type and is closed by compressed air or by hand.

SECOND only in importance to the gun mounts themselves is the question of adequate and convenient equipment for transporting and serving ammunition. Our policy provides for two types of cars, one carrying projectiles and the other powder charges. A brief description of cars recently designed for the 14-inch railway mount will apply in general to all major caliber railway artillery. The projectile car is made to American Railway Association specifications for a standard steel box car with insulated walls, and having doors at the sides and ends. The roof supports are strengthened to carry the added weight of an overhead trolley and shell hoists. The projectiles are carried on the floor of the car in two rows with their centers of gravity directly under two overhead trolley rails, and are held individually against movement in transportation by steel cradles bolted to the floor. The arrangement of the cradles is such that they will accommodate any one of the several types of projectiles used with the gun. The trolley system is provided with sliding rails which may be extended out over the track at either end of the car. In serving the ammunition, the shell is lifted by a chain hoist and carried along the trolley until it overhangs the railway track outside the car. It is then lowered on a small shot truck and moved by hand on this vehicle to a position convenient to the gun. A similar type of car is used for transporting powder. The powder containers, each holding one-half a complete charge, are supported in a horizontal position in steel racks extending the full length of the car. There are four super-imposed tiers and each can is held securely against movement in transportation. An aisle is provided at each side giving access to the removable heads of the containers. The charges are withdrawn by hand and carried to a position convenient to the gun. Each powder and projectile car transports an equal number of components of the complete charge, and not less than two cars of each type will be furnished per gun.

IN any study of the dual role of our post-war railway artillery the question of fire control must assume the great-

est importance. Considering for a moment the World War period, we will recall that railway guns were used exclusively against fixed targets. The positions of battery and target were located carefully on accurate topographical maps and the firing data measured therefrom. These data, modified by whatever ballistic and meteorological information was available, were applied directly to the gun. The only fire-control apparatus required, aside from the all-important map, were a theodolite, panoramic sight for the gun, gunner's quadrant, aiming rule or stake, and a table of logarithms. This very simple equipment was entirely satisfactory for the purpose and will continue to be so in any future war fought under similar conditions. But our new railway guns are to be used against naval targets where the conditions are quite different from those just described, and infinitely more difficult. The target is relatively small, moves at high speed and may change direction frequently. Ballistic effects are changing rapidly and must be accurately accounted for if the firing is to be successful. The element of speed both in respect to the time required to prepare the initial data and the subsequent rate of computation, is of greatest importance. The Coast Artillery has long been confronted with the same problem with respect to their heavy fixed batteries and at first thought it would appear to be perfectly logical to adapt their proven systems to this new matériel. This is not entirely feasible nor desirable, for the follswing reasons: (1) The standard Coast Artillery system depends on the availability of one or more distant observing stations accurately located with respect to the battery and connected thereto by telephones; (2) This system is slow, cumbersome and supplies data intermittently. The latter objections follow directly from the fact that a number of manually operated and interdependent instruments are used. The first objection advanced is more important from the railway artillery standpoint, as it is entirely unreasonable to assume that observing stations will be available for all firing positions open to a mobile battery, or that time will permit of establishing such accurately located stations when an engagement is imminent.

What then are the requirements for railway artillery fire control and what has been done towards developing suitable matériel since the war?

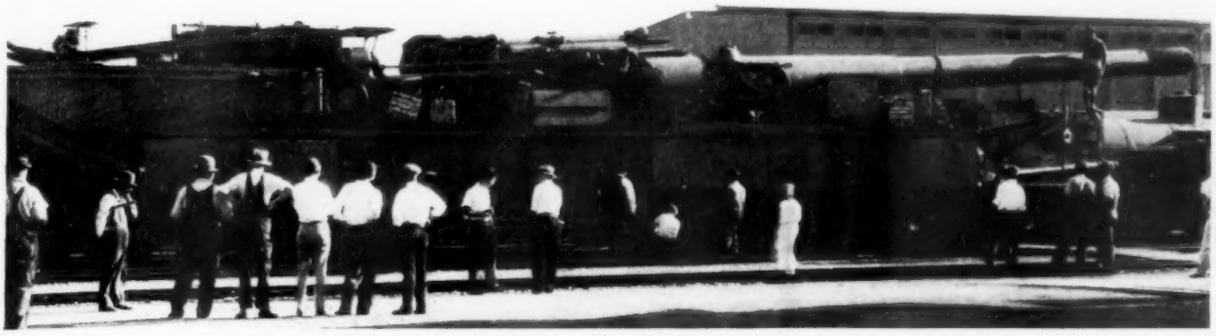
First—We should have an observing instrument located at or closely adjacent to the battery which measures the range and azimuth of the target and transmits these data over an automatic electrical system to a computer. Several range finding instruments of this type have been developed in connection with antiaircraft fire control, and they can be readily adapted to railway requirements. Second—A computing machine must be furnished which will receive the data from the observing instrument and automatically and continuously compute the future position of the target and apply all the necessary ballistic corrections. This machine should combine the functions of some five or more instruments used in the present fixed defense system. The firing data, in the form of future azimuth, future range and zone will be transmitted continuously to the gun and there displayed on data receivers. The gun will be layed continuously on the future position of the target by matching concentric pointers moving over the dials of the data receivers. One instrument of this type has been built and tested with satisfactory results. A second, somewhat less complicated and less expensive than the first, and incorporating new and desirable features, has been designed and is now under construction. A thoroughly satisfactory electrical transmission system is available. Third—A fire-control car for housing and transporting the several elements of the fire-control system is necessary. A car of this type has recently been designed for use in connection with the 14-inch railway matériel and two units are under construction.

With a system such as that just described it should be possible to go into action as soon as the gun is emplaced, and thereafter to fire accurately at a rate limited only by the speed at which the gun can be loaded.

TWO of the four 14-inch railway mounts built under our post-war rearmament program have been assigned to organizations on the Pacific Coast. The movement of these mounts by rail from the manufacturing arsenal at Watertown, Massachusetts, to Aberdeen Proving Ground, Maryland, for proof testing, and thence across the continent to stations in California has afforded a very valuable opportunity for judging the performance of the matériel on a long journey over a variety of trackage, and of the manner in which our railroads can handle such a shipment. It is especially important to know whether or not such a heavy shipment can be made without considerable delay due to conditions of tracks, tunnels, bridges, viaducts, grades and curves.

The movement of the first carriage was made in October-November, 1925 and the second in July, 1929. In each case the trip was accomplished without serious difficulty and without the necessity of modifying or strengthening any existing railway structures. In each case considerable public interest was evidenced by the large crowds of people waiting to view the mount at each stop. In the 1925 movement a great deal of stress was laid on publicity and long stop-overs were arranged at important points along the route to permit of demonstrations and lectures to interested persons. For the latter movement, however, the agreement with the railroads provided for uninterrupted movement, and placed the transport of the gun in the hands of the railroad officials. It was difficult to forecast when the gun would arrive or how long it would remain at a given place, with the result that publicity was necessarily curtailed, but on the other hand, more valuable and complete information on performance under service conditions of movement was obtained. The general findings and a few interesting details in connection with this last movement will be mentioned in the succeeding paragraphs.

The convoying party consisted of two officers and four enlisted men of the Coast Artillery Corps, a civilian proof assistant from the Aberdeen Proving Ground and railway inspectors and train personnel. The gun was made up as a part of a special train consisting of a locomotive, two idler cars for additional braking effort, two gondolas carrying accessories and supplies, the gun carriage, a Pullman tourist sleeper and a caboose. The "Coast Defense Gun Special," as it was termed by the railroads, left Aberdeen, Maryland, on the afternoon of June the 28th, and arrived at Benicia Arsenal, California, early on the morning of July 16th. The route followed is shown in an accompanying illustration appearing on pages 232 and 233. The shipment was handled by the Pennsylvania, Chicago and

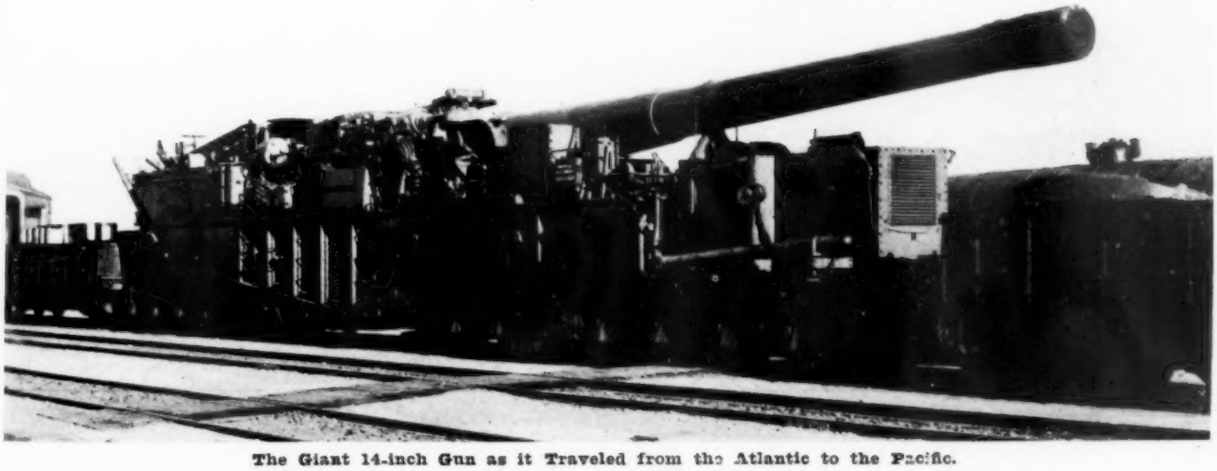


The "Coast Defense Gun Special" During a Stop on its Transcontinental Journey.

Northwestern, Union Pacific and Southern Pacific lines. The longest day's run was 279 miles and the total mileage for the trip, 3,047. The greatest average running speed between stations was 17 miles per hour and the average for the entire movement was 12.86 miles per hour. This rather low speed was dictated by the fact that the journal bearings were new and had not been run long enough to develop the maximum area of the bearing surfaces. After a period of service it should be possible to maintain a speed of 25 miles per hour on level straight-aways, with somewhat lesser speeds on curves and in mountainous country.

The officer in charge of the convoy stated at the end of the trip in his final report that there were no breakages of any parts of the mount of any consequence. There were no adverse effects on the mount as a whole, or any of its parts, as a result of the jar due to coupling the various elements of the train, or to sudden stopping or starting, or to excessive application of the brakes. This fact, in view of the variety of trackage passed over, demonstrated quite forcibly, in his opinion, the sturdy construction of the mount. All curves were negotiated easily without adversely affecting the tracks. All railroad structures were found to give ample clearance both vertically and horizontally, and in the case of bridges no vibration or noticeable deflection of the structures was detected. The brakes functioned effectively at all times and on long grades the steel brake shoes gave no indication of excessive wear or heating. There was no known breakage of tracks or other railway equipment aside from the draft gear of a gondola forward of the mount. The broken parts were replaced at a car shop enroute where an examination revealed that the parts were probably defective prior to the departure from Aberdeen.

It is evident from the foregoing that this largest of railway gun carriages can be moved expeditiously and without difficulty over any main line road in the United States. The other important performance characteristics, including facility of emplacement, rate of fire and ease of handling have been demonstrated in extensive tests at the proving ground. Hence, we are justified in regarding it with some confidence as a thoroughly modern piece of ordnance meeting fully the requirements of the Caliber Board and of great potential value in the defense of the country.



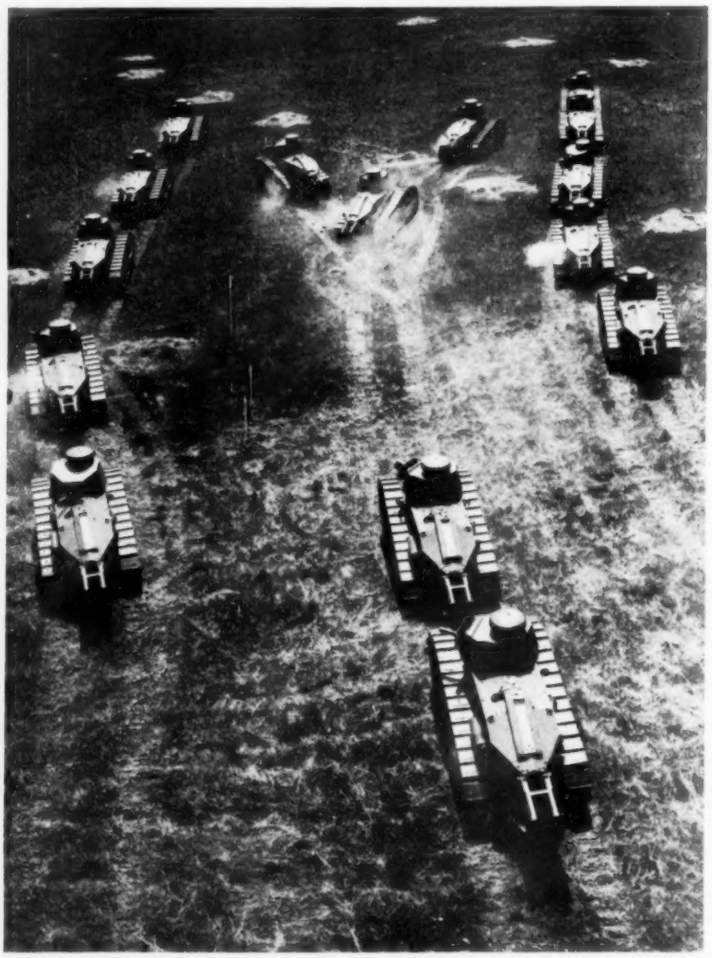
The Giant 14-inch Gun as it Traveled from the Atlantic to the Pacific.

Tank Reorganization

Demands and Possibilities of Increasing Battle Mobility

By Sereno E. Brett*

REORGANIZATION seems to be the order of the day. It is submitted that any reorganization should be accepted solely for the purpose of increasing battle mobility. Battle mobility is the only logical objective for any organizational study. It is all-encompassing and is the essence of successful combat. It embraces fire power, movement, supply, security, mental processes and all other phases of battle. Any attempt to set up numerous requirements for reorganization is certain to invite confusion, the introduction of useless equipment, formations and methods, and the adoption of complex and unwieldly organizations. In the last analysis, it is simply the question: Will or will not this gun, this type of transportation, this method of supply, reconnaissance or security, this formation, this system of coöperation or coördination, etc., increase our battle mobility?



A Present Day Tank Maneuver—Up-to-date Equipment and Organization will increase Battle Mobility Tremendously. These are Old Timers; The Newer Vehicles can Play Rings Around Them.

The present day possibilities of increasing battle mobility are demanding reorganization and reëquipping. This reorganization must not again produce static units, but in the future must be a continuing process if we are to make full use of the developments in the prolific scientific field in our scheme of national defense.

The reorganization of rifle units of the infantry is now undergoing serious and practical study. It is also important that we analyze our tank organizations. Tremendous possibilities for offensive and defensive power have been developed with kaleidoscopic speed in the automotive field within the past few years. Antitank methods have received the most serious consideration in foreign armies since the World War, and in most of those armies powerful armament is provided for security against armored vehicles. In face of all these developments and the ever increasing number of tank enemies, our tank organization remains practically the same as in 1918. Even the lessons we learned in combat have not been applied to our post-war tank organization.

There is little question but that the present tank organization, confronted by modern antitank means, will produce little but grief for tank commanders, and probably considerable embarrassment to the tactical plan of the higher commander who is depending on tank support. The tank is a most powerful weapon, but we must give it a chance to live by giving it a usable, well-balanced organization. At least it must keep pace with its enemies if it is to remain on the battlefield. Here again, it is important that the reorganization should be a continuing process, but there are certain drastic changes which should be made now to modernize the tank service.

IN any organization study of tank units, it is necessary first to determine the basic characteristics of the individual unit—the tank. When these basic characteristics, good or bad, have been determined, it is then necessary to determine how the good ones can be exploited and the effect of those which are bad minimized through intelligent and progressive organization. The outstanding characteristics of the tank are: protected mobility, protected fire power, shock action, poor combat vision, dependence on supplies, relatively poor power of concealment, vulnerability to antitank weapons, and the limitation of its powers

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by antitank terrain. It can be seen readily that the good characteristics are most desirable on the battlefield, but when the poor characteristics are critically analyzed the uninitiated are apt to ask embarrassing questions about the sum total result of the balance between the good and bad. Based on our present organization, the tank officer of today must do considerable squirming before he can produce a satisfactory answer. He has for years been juggling with abstract thoughts on coöperation, teamwork, and so on, which may or may not have developed in him a sense of false security. If he has been analytical to the smallest degree he will have come to the realization that he has not in his own command those elements, normal to every battle, which will give him a powerful, well-balanced weapon. He must ask outside agencies for his normal needs—his smoke, his artillery protecting fires, his engineer support and his communications. Also he realizes that his supply and maintenance echelons have not the mobility of his combat echelon.

With this makeshift team he has the ball snapped to him and he attempts to "carry on." Vital members of his team he has never seen before and are working with him only on a supporting basis. The team has never practiced a single normal play together, and the mobility, training and equipment of his supporting members are not suited to his needs.

Maneuvers Such as These are Good to Look at but no Battle yet has been Won by Good Looks.

The progressive tank officer has a vision of a powerful well-balanced team; a team sufficient within itself to meet the normal events of a good tank fight, and a unit which is able to give intelligent and powerful support to the rifle units it is supporting. Such a dream will become a reality only by a reorganization which will exploit fully the powers of the tank and provide those elements which are normal and necessary to every tank fight. Again, the objective of such a reorganization should be to increase the battle mobility of the tank unit thus making it a much more flexible and powerful aid to the supported rifle troops.

Study any tank action and it can be seen readily that there are certain elements which, had they been provided in tank organizations, would have greatly increased the battle mobility and, incidentally, the battle life of the tanks. A relatively small number of tanks with properly balanced supporting services unquestionably will accomplish more than a large mass without such support or a larger number depending on the very uncertain support from outside agencies which must be secured through a complex system of liaison or communications. When certain classes of support are needed by tanks that support must "click" or the action is over and the battlefield becomes a tank graveyard. Witness the frightful execution done at Flesquieres by one German officer manning a 77-mm. gun. Purely a case of a gun against a mass of unsupported tanks. The immediate result, sixteen tanks knocked out in a few minutes; the real result, the failure of the infantry division to reach its objective due to the loss of tank support.

SPECIFICALLY those elements or services which are needed to make up a properly balanced and more effective tank organization are, smoke, antitank gun destroyers (self-propelled artillery), pioneers, antiaircraft protection, reliable and fast communication, and suitable and sufficient reconnaissance, command, maintenance and supply vehicles. Just how to fit these services into the scheme of organization to give tank units proper balance must be determined by practical and extensive field tests. They are, however, as necessary to tank organizations as are the various auxiliary weapons the rifle units were forced to adopt when confronted with modern battle conditions.

It is inconceivable in modern war that tanks should not make use of smoke as fully as is practicable. Aside from the smoke produced on general areas by supporting artillery or aircraft, tanks should have smoke immediately available to them for neutralizing hostile antitank guns and OP's and for covering their withdrawal, their maneuver against hostile armored vehicles and for many other purposes. This requirement for smoke within the tank organization immediately brings up the question as to how it should be pro-

duced. Obviously, the simplest way would be to provide smoke shell for the tank cannon. However, the small caliber of the cannon and the limited amount of available ammunition precludes the possibility of developing an adequate volume of smoke by this means. Another method, which has received considerable attention experimentally, is to provide the tank with a smoke-producing apparatus which can be turned on and off at will. The release of smoke clouds by the tank itself is not favorably considered in many tactical situations. However, the many situations, such as screening a maneuver of the tanks, it should prove to be very efficacious.

Artillery support is a constant need of assaulting tanks. Divisional artillery, by its preparation fires and concentrations or barrages, assists, of course, in breaking down the general resistance. During the actual assault, however, tanks must have immediate artillery support to engage antitank weapons and to assist in the destruction of hostile tanks if encountered. Hostile antitank weapons will remain concealed until our tanks offer a favorable target. Due to their poor vision, it is almost a hopeless task for a tank definitely to locate an antitank gun in the excitement of battle. Under our present organization, if a hostile antitank gun be located, the tanks have two alternatives open to them: First, to call for support from the divisional artillery or infantry auxiliary weapons, and second, to rush the gun themselves. The time necessary to secure support from outside agencies, even with the most perfect communications now employed, is so long that it permits hostile antitank guns to exact frightful toll of our assaulting tanks. During the World War tanks almost invariably chose the second alternative; rushed the gun and took their losses. This method of overcoming antitank defense was most costly then—now, with a highly developed system of antitank defense, and without effective supporting fires, it would be rank suicide. What is needed is a gun of sufficient mobility to operate directly with the tank combat echelon; this gun to take position behind the assault waves and cover the advance of the tanks from one local objective to another. The gun, or guns, should be an organic part of the tank unit, as training in the recognition of antitank targets and in tank tactics is of paramount importance. During the last war such a gun would have been invaluable—in future war, because of the vast increase of tank enemies and the necessity for decentralizing support due to the increased mobility of the tank, this type will be indispensable.

Before and during action engineer service is constantly required by tank units. Routes must be reconnoitered, marked and often prepared; obstacles must be removed; bridges strengthened and fords prepared through streams; mine fields destroyed or rendered harmless and so on. At present the tank commander must ask for engineers to be detailed from other important works to render this service. If he gets them, he finds they are not specially trained to his needs and they are not equipped with proper tools or transportation. And again the tail wags the dog! A small detachment of pioneers is needed—probably in the battalion headquarters company—to meet engineer requirements of normal tank operations. The personnel, of course, should be specially trained and equipped with proper tools and adequate cross-country transportation.

AT present our tank organizations are totally unprotected from air attack. They have no weapon which can be brought to bear against hostile aircraft. It is not recommended at this time that antiaircraft units should be included in tank organizations, but some thought should be directed toward the employment of present tank weapons against hostile aircraft, while on the march or in bivouac, or it may be found desirable to issue additional weapons, such as the caliber .50 machine gun, to provide additional protection.

Tanks operate on relatively wide fronts. Hence, fully to exploit the mobility of the tank and to insure greater flexibility and ease of control, the most rapid applicable means of communication should be developed and provided for tank units. Slow means of communication seriously reduce the battle mobility of tanks and cause delays which may prove disastrous. Our present organization provides radio telegraph down to the company. From the company down the only dependable means of communication provided for combat is the runner. True, the company is provided with a cross-country car and two motorcycles, but these are required for necessary reconnaissances, for communication with supply and maintenance echelons and in maintaining liasion with the unit supported. With the combat echelon of a company operating over an area roughly 1200 yards wide by 1500 yards deep it readily can be seen that runner communication is so slow as practically to paralyze the unit. The British have been experimenting for several years, and have had considerable success, with radio telephony for tanks. At present some of the units of the Royal Tank Corps are equipped with radio telephone receiving sets to include the individual tank. It requires no particular intelligence to determine the relative value of tank units controlled by radio telephone and partially armored command vehicles and similar units controlled solely by runners.

Reconnaissance, before, during and after action, is of vital importance in tank operations. Suitable vehicles, in sufficient quantities, must be provided to insure rapid execution of reconnaissances, else the battle mobility of the tank again slows down to the pace of the reconnaissance service. Often reconnaissances must be carried out under small arms fire. Therefore, reconnaissance vehicles must be provided with some armor protection to allow them to negotiate fire-swept areas, secure desired information as rapidly as is possible, and stand some chance of returning with the information. A vehicle similar in size to the British Carden-Loyd, preferably a wheel-cum-track type, will probably answer the requirements of a tank reconnaissance vehicle.

Balancing of organizations, along the above lines is most desirable even in our present tank units equipped with slow-moving war-time tanks, if we wish fully to exploit the powers of this weapon and give it a chance to survive modern battle. With the adoption of modern fast tanks this balancing will become more necessary if we are to derive full benefit from its increased mobility. It will increase immeasurably the flexibility and range of uses of tank units by eliminating the drag from the rear. Basic training will take the place of the present multitude of details connected with coördination on the eve of battle.

Armor Plate

The Possibility of Utilizing Low Carbon Industrial Steels

By Roy E. Paine*

THE competition between the manufacturer of armor and the maker of armor-piercing projectiles began on the day when armor plate was first used as a defensive method. Improvements in armor plate brought out more effective projectiles. The race between armor and projectile is still in progress today and it is found that the projectile holds the lead. Under reasonably favorable conditions, guns and projectiles can be made which will pierce any armor which can be produced and not have weight so great as to be infeasible. The development of steels for armor plate to compete in this unending contest is a constant call on the resources of the metallurgist.

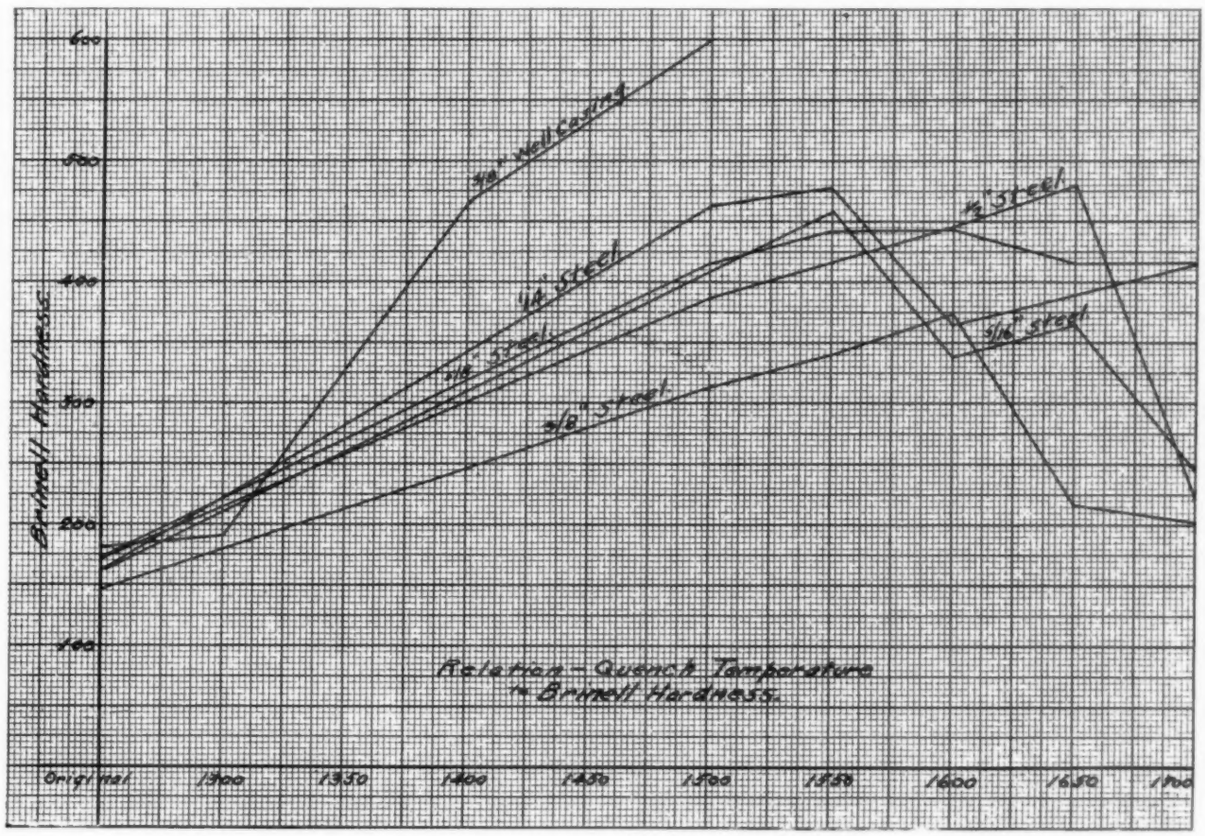


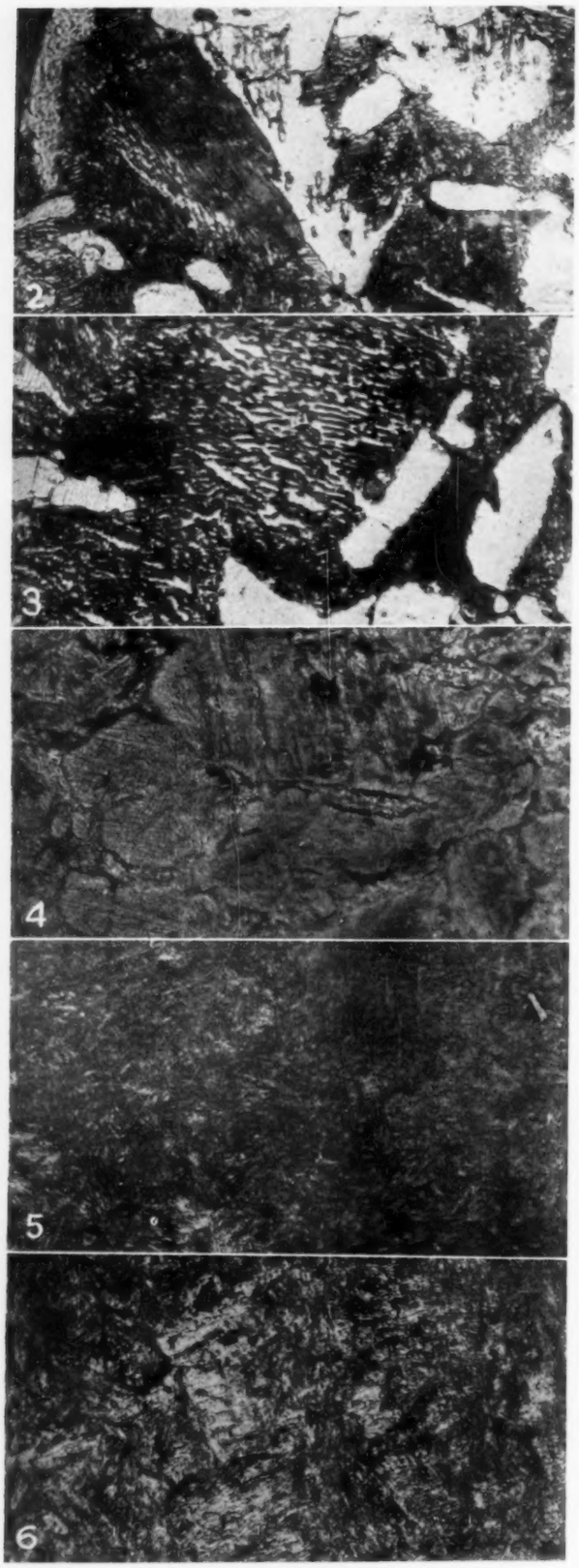
Fig. 1. Relation of Quench Temperature to Brinell Hardness.

The use of metals as a means of protection in times of war extends far back in the history of civilization. The smiths of former times made use of such iron, steel, and other metals as were available. Malleability and forgeability were prime requisites. Resistance to penetration was little needed at a time when only swords, spears, and arrows were used. In 149 A.D. it is recorded that during the third Punic War between the Romans and the Carthaginians, the warriors of Carthage protected some three hundred vessels with wrought iron plates. The ships in which the Normans cruised about the waters of northern Europe were often partly armored with metals. During the Crusades, the warriors were protected by whole suits of metallic armor, and the Knights of St. John of Jerusalem used armored galleons for the siege of Tunis.

Armor must have been a great handicap in those days when vessels were propelled by slave labor and by the wind, and its little use is not strange. The cases mentioned are undoubtedly exceptional. For centuries vessels of war were unarmored. In Nelson's time, England placed complete reliance on the oak sides of her line of battle ships. The armoring of ships received no impetus with the advent of steam for navigation.

In the first half of the nineteenth century great progress was made in the development of artillery, and immediately it became necessary to develop armor plate for ship's protection. This need for armor soon became urgent when, early in the nineteenth century, General Paixhans invented

*Metallurgist, Stanford University, Calif. This article was awarded first prize in the 1928 annual essay contest sponsored by the California Post, Army Ordnance Association, open to members of the R. O. T. C. Ordnance Units at University of California and Stanford University.



Absorption of Free Ferrite.

Figs. 2 to 6. ⅜-Inch Well Casing. 2. Original Structure, as Rolled; 3. Quenched from 1300° F. in Water; 4. Quenched from 1400° F. in Water; 5. Quenched from 1450° F. in Water; 6. Quenched from 1500° F. in Water. (All x 1000.)

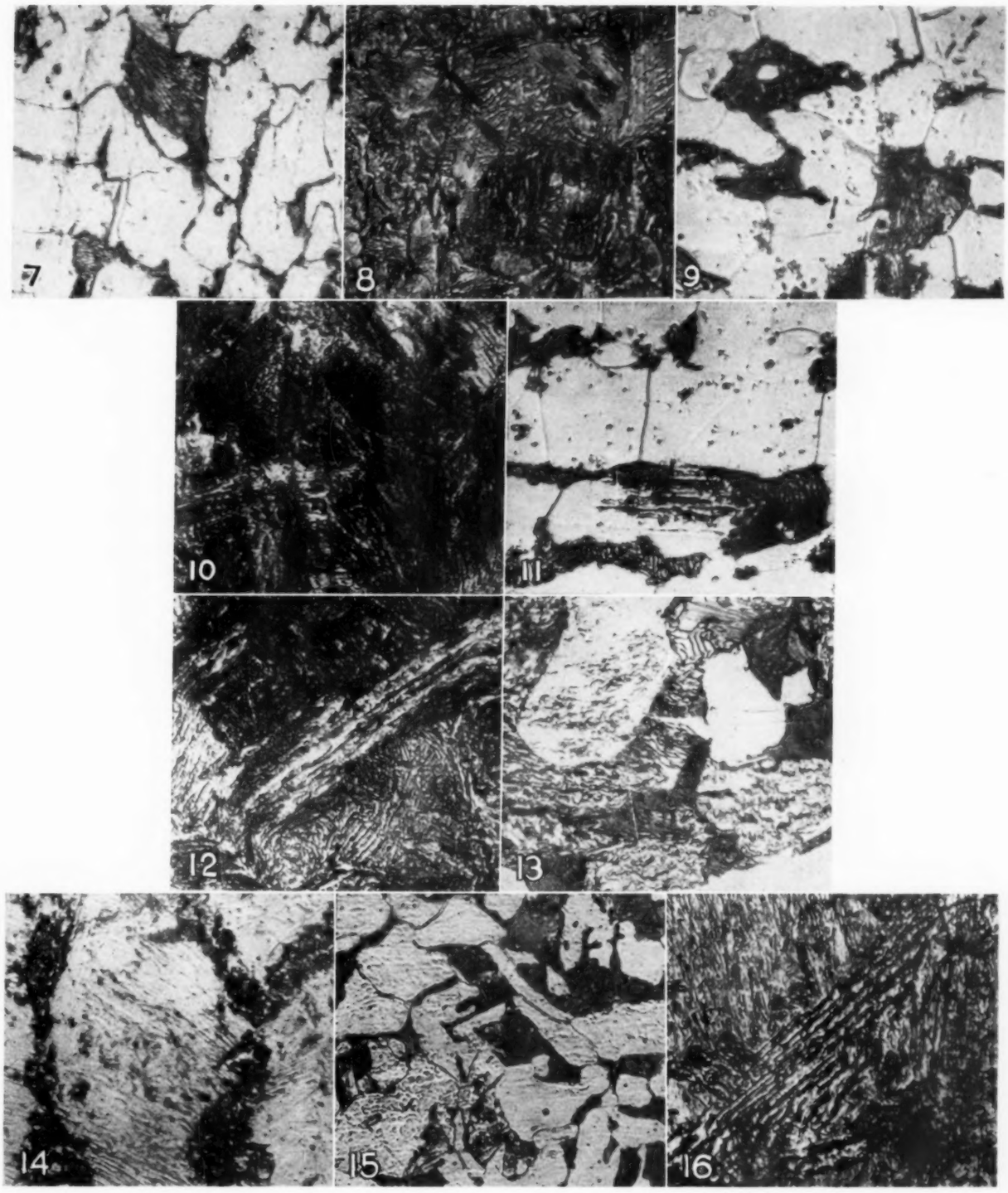
an explosive shell which burst on contact. During the Crimean War the French used floating batteries fitted with four and one-half inches of armor plate. The success of these batteries in action induced the French to build the iron frigate, La Gloire, which was armored with a four inch belt at the water line. This vessel was launched in 1858 and since that date practically all warships have been armored. Consequently, since that time, methods for the production of better armor plate for the navies of the world have received great study in the United States, England, France, and Germany.

The first plates of modern armor were fabricated from wrought iron. Projectiles developed so rapidly that it soon became necessary to find a metal more resistant to penetration than iron. Compound plates were used, but the advent of new steel-making processes made the production of large homogeneous plates a possibility. The climax came during the nineties, when Harvey produced his first plates hardened by cementation, and the Krupps of Germany replied to this with their famous plate of nickel-chromium steel with a cemented face. The trials at Annapolis and at Indian Head in 1891 proved the worth of the Harvey plate, and since 1896, it and the Krupp plate have filled all the needs for ship's armor. The thickness of plates has been increased in proportion to the increased power of guns and projectiles, and some slight variations in composition have taken place, but, fundamentally, the present day plates are the same as those originally produced by Harvey and Krupp.

The development of steel for the protective armor of modern field guns, sea coast guns and auxiliary matériel has proceeded along the same lines as has the development of heavy ship's armor, and practically the same steels are used. However, the face of the lighter armor is not hardened by cementation.

AT the beginning of the World War, guns, howitzers, major caliber guns and all the accompanying matériel were far enough behind the lines to need little or no protection from rifle fire, and they were sufficiently protected from fragments of explosive shells by the steel plates they carried. Shortly after the opening of the war, it became evident that the armies in the field intended to intrench themselves, and to fight by mass artillery preparation from the rear and by concerted attacks of infantry in rushes from the trenches. With the trend of tactical conduct of the war in this direction, it became evident that a piece of matériel built of armor plate and of a size sufficient to protect one or several men, would have great value in enabling men to venture into the wastes of "no man's land." The need produced many novel appliances, but one stood out above all. The tank developed and first used in large number by the British Army had a value which cannot be overestimated, and at least to some degree the final victory of the Allies may be attributed to it.

Without armor plate, tanks would have proved of small value and throughout their history, can be traced the development of an armor plate which is light enough to maintain maximum mobility of the vehicle and having resistance to penetration, high enough to prevent the entrance of the German Mauser bullet, which was fired either point first or reversed. In the reversed position, its penetrative power was great.



Microstructure of Steels Before and After Heat Treatment.

7. ¼-inch Steel Plate; Original Structure, as Rolled; 8. ¼-inch Steel Plate; Quenched from 1550° F. in Water; 9. 5/16-inch Steel Plate; Original Structure as Rolled; 10. 5/16-inch Steel Plate; Quenched from 1550° F. in Water; 11. ⅜-inch Steel Plate; Original Structure, as Rolled; 12. ⅜-inch Steel Plate; Quenched from 1600° F. in Water; 13. ½-inch Steel Plate; Original Structure, as Rolled; 14. ½-inch Steel Plate; Quenched from 1650° F. in Water; 15. ⅝-inch Steel Plate; Original Structure, as Rolled (x 500); 16. ⅝-inch Steel Plate; Quenched from 1600° F. in Water. (All, except 15, x 1000.)

Since the war, experiments have continued in the production of a more resistant armor. The armies of the world are developing tanks for future emergencies and their armor is always a major problem. There will be always a large amount of other matériel which must have protective armor, and any cheaper means of procuring it will be of interest to ordnance metallurgists. This paper is written to record some experiments in the possibility of utilizing certain industrial steels as armor plate.

The motive which actuated the experiments herein recorded was the desire to determine if a heat-treated plain carbon steel could be developed which might replace the more expensive alloy steels now in general use. Armor plate is designed to prevent bullets or projectiles from entering regions it protects and doing damage to men and to matériel. The thin armor of helmets, breastplates, and gun shields is less than ½-inch thick and is intended to afford protection against shrapnel and splinters of shell fragments. Tank armor is as heavy as ⅝-inch and must keep out service and armor-piercing bullets and one-pounder projectiles at very close ranges. The production of armor light enough to mount on mobile artillery and on tanks and capable of affording maximum protection presents an interesting but difficult problem.

THE penetration of armor takes place by a combination of two different actions of the projectile, "punching" and "boring." When a caliber .30 service bullet strikes a thin armor plate it punches out of the plate a piece slightly larger than the cross section of the bullet. This action will result as long as the resistance of the plate is less than the energy or strength of the projectile. When the caliber .30 armor-piercing bullet strikes a plate which it is capable of penetrating, it sets up a wedging action. This action is a tendency to separate the molecules of the plate and to force them sufficiently apart to allow the bullet to pass. This action is assisted by the rotary motion of the bullet and is very similar to the action of a drilling machine. Such work, of course, absorbs the energy of the bullet, and if the plate is thick enough it will bring the projectile to rest. If the plate is sufficiently strong and hard enough to resist the point of the bullet at the moment of striking, the point will be destroyed and boring will be prevented.

The experience of naval armorers late in the nineteenth century and early in the twentieth century showed that steel armor was far superior to wrought iron or cast iron plates, and consequently, the armies of the world sought in steel, protection for matériel and personnel. In selecting a steel for light armor one should give attention to two factors. First, the hardness and tensile strength of a steel may be improved by increase in the carbon content, but as the carbon content is increased the steel will have progressively lower ductility and will finally become very brittle. Second, a plate may be made so thin that no matter what physical properties it may possess it will be penetrated. And on the other hand it may be made so thick, that, no matter what its nature, its mass will be sufficient to resist penetration. Under the latter condition, the plate will be very costly and its weight will be prohibitive for use in mobile matériel.

During the World War light armor was manufactured from high grade electric or crucible steels, having a carbon content from 0.25 to 0.70 per cent and alloyed with varying amounts of any one or several of the elements, nickel, chromium, molybdenum, and tungsten. These alloy steels, when properly heat treated, have high strength and hardness, and at the same time sufficient toughness and ductility to prevent shattering or fracture by impact.

Alloy steels produced in the electric furnace or in the crucible are expensive and require highly skilled workmen for their production. The experiments recorded in this paper have been carried out to determine the possibility of utilizing low carbon hot rolled steel, in a heat-treated state, for the armor of field guns, tanks and like matériel. Steels of this class can be produced cheaply and in large quantities in the open-hearth furnace, and it has been found that by careful heat treatment high ultimate strength and great hardness may be obtained in them without loss of ductility. Little attention has been paid to the possibilities and use of heat-treated low carbon steel. Some writers on the subject dismiss the matter by stating that hot rolled steel of less than 0.30 per cent carbon cannot be greatly improved by heat treatment. Later investigators have found that such is not the case, for if certain conditions are observed it is possible to obtain a useful increase in the properties of these steels by heat treatment.

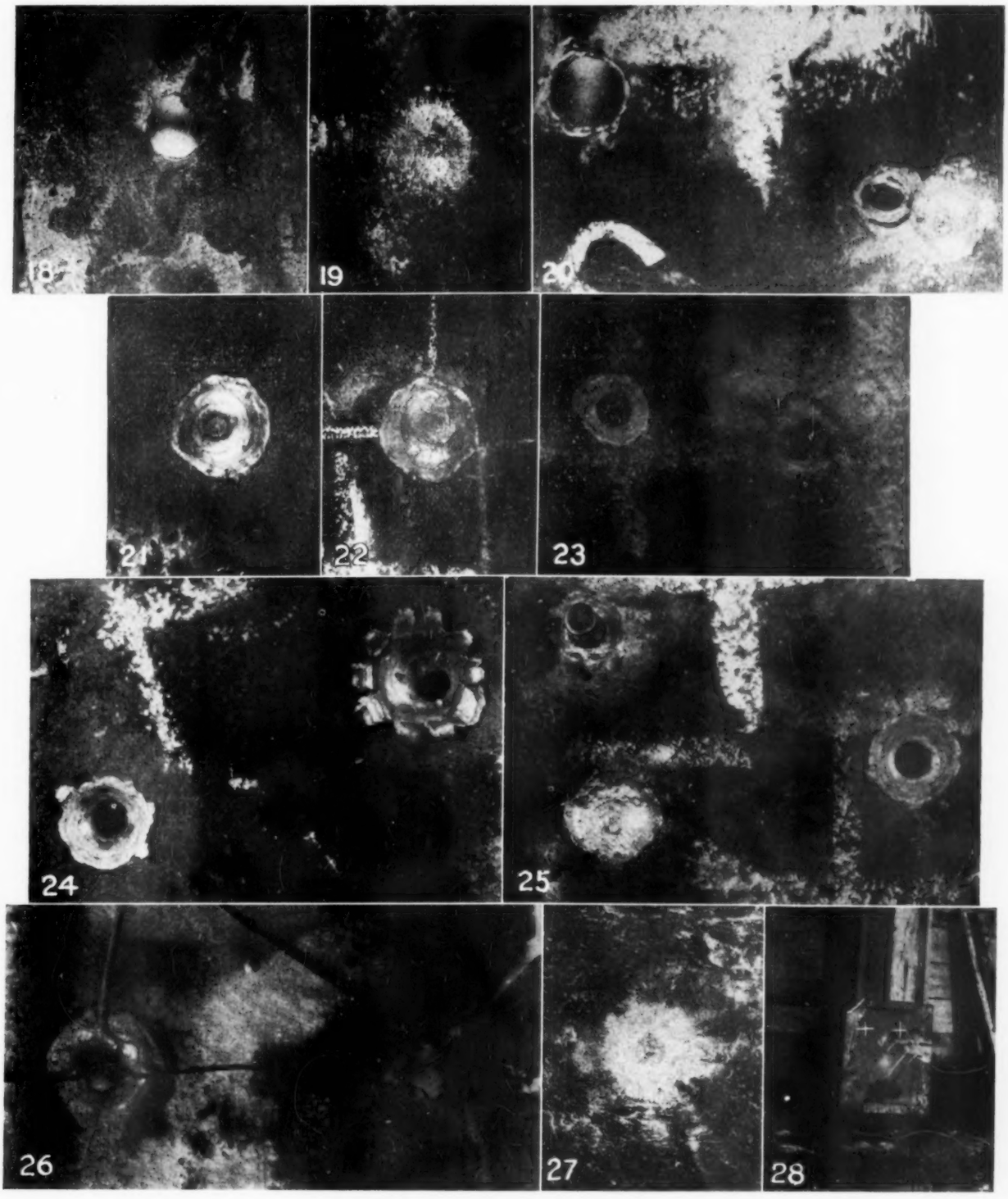
Fig. 17. Arrangement of Steel Plates at the Butts for Ballistic Tests.

Two general conditions must be observed in order to make low carbon steels respond to heat treatment. First, heating for hardening must be carried on at a temperature at which all the free ferrite will be absorbed into the solid solution phase before the steel is quenched. This temperature must not be greatly in excess, however, as grain growth will take place with attendant decrease in hardness and strength. Second, it has been learned from microscopic study that if the manganese content of the steel is less than 0.50 per cent it is not possible to retain the free ferrite in the solid solution phase when the steel is quenched. When the manganese content is in excess of 0.50 per cent, then there is a temperature slightly above the upper critical point at which all the free ferrite will be absorbed on heating and will be retained in solid solution on water quenching. This heating and quenching results in a martensitic structure, which gives greater strength and hardness than was possessed by the original steel.

By subjecting low carbon steels to a simple test, known as a "regeneration test," their reaction to heat treatment may be determined. This test determines whether or not a steel is capable of absorbing all of its free ferrite and of retaining it on water quenching.

THE steels tested in the experiments about to be described have been treated according to the foregoing principles and have been tested ballistically. The experimental work comprised the following operations:

1. The selection of the steel.
2. The conduct of the "regeneration tests" to determine the proper quench temperature.



Figs. 18 to 28. Results of Ballistic Tests.

Fig. 18. Penetration of ¼-inch Heat-treated Plate by Service Ammunition at 100-yards. Brinell Hardness—555. Fig. 19. Resistance of ⅜-inch Heat-treated Plate to Service Ammunition at 100-yards. Brinell Hardness—228. Fig. 20. Penetration of ⅜-inch Heat-treated Plate by Service and Armor-piercing Ammunition at 100-yards and 20-yards. Brinell Hardness—321. Fig. 21. Resistance of ½-inch Plate as Received to Service Ammunition at 100-yards. Brinell Hardness—170. Fig. 22. Resistance of ½-inch Heat-treated Plate to Service Ammunition at 20-yards. Brinell Hardness—387. Fig. 23. Penetration of ½-inch Heat-treated Plate by Armor-piercing Ammunition at 20-yards; at 100-yards the Armor-piercing Bullet Stuck in Plate. Brinell Hardness—477. Fig. 24. Penetration of ⅝-inch Plate as received by Armor-piercing Ammunition at 100-yards and at 20-yards. Resistance to Service Ammunition at 20-yards. Brinell Hardness—170. Fig. 25. Resistance of ⅝-inch Heat-treated Plate to Armor-piercing Ammunition at 100-yards and 20-yards, and to Service Ammunition at 20-yards. Brinell Hardness—228. Fig. 26. Fracturing of ¾-inch Well-casing Steel Caused by Penetrations of Armor-piercing Bullets at 100-yards and at 20-yards. Brinell Hardness—515. Fig. 27. Resistance of ¾-inch Well-casing Steel to Service Ammunition at 100-yards. Brinell Hardness—340. Fig. 28. Penetration of ¼-inch Tractor Armor by Armor-piercing Ammunition at 100-yards.

3. The heat treatment of the plates to be tested ballistically.

4. The ballistic tests.

5. Heat treatment of tensile test bars and determination of the physical properties of the steel.

The steels used were manufactured by the basic open-hearth process, hot rolled and allowed to cool on the hot beds. The specimens for ballistic tests were cut from 4 inch by 4 inch angles and 6 inch by 6 inch angles. The carbon content was approximately 0.20 per cent and the manganese content approximately 0.60 per cent. There was also on hand a piece of seamless well casing containing 0.37 per cent carbon and 0.85 per cent manganese which was heat treated and tested with the other steels. Time did not allow tests to be made on steels of higher carbon. The following table gives the chemical analyses of the steels used.

TABLE I
Chemical Analyses of Steels Tested

THICKNESS Inch	C Percent	Mn Percent	P Percent	S Percent
1/4	0.22	0.61	0.018	0.077
5/16	0.21	0.59	0.011	0.055
3/8	0.18	0.57	0.017	0.068
1/2	0.22	0.59	0.012	0.051
5/8	0.24	0.75		
3/8 well casing	0.37	0.85	0.016	0.029

The physical properties of the steels as received were determined on the Brinell hardness tester and by use of a 100,000 pound Universal tensile testing machine. The form of test bar used was that recommended by the American Society for Testing Materials. The following table gives the properties of the steels tested in the original condition.

TABLE II
Physical Properties of Steels as Received

THICKNESS Inch	BRINELL HARDNESS	ULTIMATE STRENGTH Lbs. per sq. in.	ELASTIC LIMIT Lbs. per sq. in.	ELONGATION Percent in 2 inches	REDUCTION OF AREA Percent
1/4	163	77,300	56,720	15.6	27.0
5/16	163	72,640	51,800	34.3	51.0
3/8	149	66,800	46,090	42.1	44.8
1/2	170	72,200	48,000	40.6	46.0
5/8	170	76,200		36.7	48.8
3/8 well casing	183		Not available		

The microstructure of these steels was found to be similar to that of ordinary low carbon steel in the normal condition. It consisted of a network of polyhedral grains with the usual pearlite areas, and is illustrated by photomicrographs in Figs. 7, 9, 11, 13 and 15.

THE steels were subjected to a "regeneration" test to determine the proper quench temperatures. The technique of this test is simple and is conducted as follows. Similar pieces of the steel are heated for a uniform period of time, of such duration that the pieces are uniformly heated to the center, at a series of temperatures starting at 1300°F. 1400°F. or 1500°F. according to the carbon content and increasing by 50°F. or 100°F. steps, followed by a water quench. If the steel is capable of absorbing its free ferrite and of retaining it in solid solution, Brinell tests will show a regular increase in hardness for each increase in quench temperature. A quench temperature will be reached where the hardness will be found to drop off. The temperature at which maximum hardness occurs is the proper quench temperature. Quenching from any lower temperature will not result in complete absorption of the free ferrite and quenching from any higher temperature will result in enlargement of grains and consequent decrease in desired physical properties.

The "regeneration" test specimens used in the experiments measured about 1⅛ inches by 1¾ inches. They were heated in a Hoskins electric furnace under automatic pyrometric control and were quenched in cold water. For the steels of 0.20 per cent carbon, a temperature of 1500°F. was taken as the starting temperature, and for the piece of well casing steel the initial temperature was 1300°F. The specimens were held at temperature for thirty minutes. The results of "regeneration" tests are shown in Table III, and graphically in Fig. 1.

TABLE III
Regeneration Test Results

TEMPERATURE °F	BRINELL HARDNESS 1/4	5/16	3/8	1/2	5/8	3/8 well casing
Original	163	163	149	170	170	183
1300	...	...	...	...	...	187
1400	...	...	...	...	...	460
1450	...	...	...	...	...	535
1500	460	311	311	387	415	602
1550	477	460	340	415	444	...
1600	364	331	375	444	444	...
1650	...	364	217	477	415	...
1700	415	241	202	223	415	...

The results of "regeneration" tests may be studied microscopically and the gradual absorption of free ferrite noted with increasing quench temperature. Complete absorption, or nearly complete absorption of the free ferrite, occurs in the steel which has the maximum Brinell hardness; this steel will have the most satisfactory physical properties. This absorption of free ferrite is illustrated by the series of photomicrographs shown in Figs. 2 to 6. This series shows the complete change of the steel, in the normal condition, into a martensitic structure, developed by the complete migration of the carbon across the ferrite areas, and the consequent complete absorption of the free ferrite.

THE "regeneration" tests served to indicate the quench temperatures to which the steel plates for the ballistic tests should be heated in order to obtain satisfactory physical properties. The temperatures to which the steel plates were heated are indicated in Table IV. These plates were 4 inches by 11 inches in size, excepting for those of ⅝-inch thickness which were 6 inches by 12 inches. As noted in the table the thinner plates were heated for 30 minutes at the quench temperature, while the others were heated for 40 minutes. The furnace used was a General Electric Company, 10 kilowatt, electrical resistance heat-treating furnace, controlled by Leeds and Northrup Potentiometer System Temperature Recorder. All plates were quenched rapidly in cold water.

The Brinell hardness was taken at each end and in the center of each plate and the results are shown in Table IV.

TABLE IV
Brinell Hardness of Quenched Plates

THICKNESS Inch	TEMPERATURE °F	TIME Min.	BRINELL HARDNESS		
1/4	1550	30	477	555	340
5/16	1550	30	477	444	364
3/8	1600	40	387	228	217
1/2	1650	40	460	387	387
5/8	1600	40	228	302	269
3/8 well casing	1450	30	515	340	415

The microstructure of the heat-treated plates is shown by the photomicrographs in Figures 8, 10, 12, 14 and 16. This structure is in every case troostomartensitic.

The physical properties of the steels in the heat-treated condition were determined in the tensile testing machine using the standard test bar previously described. The bars were heated to the temperatures and for the times noted in Table IV for the ballistic specimens. As heat treated, the bars measured 2 inches by 12 inches, and they were afterwards machined to the standerd test bar size. Table V shows the Brinell handnesses obtained on the tensile specimens, and Table VI shows the results of the physical tests.

TABLE V
Brinell Hardnesses of Tensile Specimens

THICKNESS Inch	TEMPERATURE °F	TIME Min.	BRINELL HARDNESS	
1/4	1550	30	340	477
5/16	1550	30	401	444
3/8	1600	40	387	387
1/2	1670	40	387	444
5/8	1600	40	340	340
3/8 well casing	Not available			

TABLE VI
Physical Properties of the Heat Treated Steels

THICKNESS Inch	BRINELL	ULTIMATE STRENGTH Lbs. per sq. in.	ELONGATION Percent in 2 inches	REDUCTION OF AREA Percent
1/4	477 555 340	149,640	broke outside	14.0
5/16	477 444 364	124,330	6.2	10.0
3/8	387 228 217	104,770	18.7	38.0
1/2	460 387 387	104,320	17.2	28.0
5/8	228 302	141,900	7.8	8.4
3/8	515 340	Not available		

STEEL plates, both in the normal and heat-treated condition, were tested ballistically with a caliber .30 Browning machine gun giving a muzzle velocity of 2,700 feet per second. The ammunition used was 1918 service and armor-piercing loaded with the normal charge. Firing was conducted at ranges of 100 yards and 20 yards. The plates were supported by a butt of 2-inch seasoned pine. They were placed upright and held in position by a nail driven into the wood and bent over the edge of the plate. An idea may be obtained of the arrangement of this support by the photograph shown in Fig. 17. No attempt was made to determine the relative velocities of the armor-piercing bullets nor of the slugs after penetration of the steel was effected. This could have been done by use of a series of boards spaced equally behind the specimens, but was deemed unnecessary in work of a preliminary nature. Table VII shows the results of the ballistic tests. In the table the steel plate, as tested in the original condition, precedes the plate of the same thickness in the heat treated condition. The table shows whether or not the steel was penetrated by the ammunition at the range noted. These results show that the 1/4-inch and 5/16-inch steel plates tested were penetrated by service ammunition at 100 yards. At the same range, with service ammunition, the 3/8-inch treated, and the 1/2-inch and 5/8-inch treated and untreated plates resisted penetration.

TABLE VII
Results of Ballistic Tests

THICKNESS Inch	BRINELL HARDNESS	PENETRATION EFFECTED 20 Yards Range SERVICE	20 Yards Range A. P.	100 Yards Range SERVICE	100 Yards Range A. P.
1/4	163	...	...	yes	...
1/4	477 555 340	...	...	yes	...
4/16	163	...	...	yes	...
5/16	477 444 364	...	...	yes	...
3/8	149	...	...	yes	...
3/8	387 228 217	...	yes	yes	...
1/2	170	...	yes	no	yes
1/2	460 387 387	no	yes	no	no
5/8	170	no	yes	...	yes
5/8	228 302 269	no	no	no	no
3/8 well casing	515 340 415	...	yes	no	yes

At 100 yards with armor-piercing ammunition, the 1/2-inch and 5/8-inch heat-treated plates resisted penetration. At twenty yards with service ammunition the 1/2-inch heat-treated plate and the 5/8-inch untreated and heat-treated plates resisted penetration. At 20 yards with armor-piercing ammunition, only the 5/8-inch heat-treated specimen resisted penetration. The results of several of the shots are best illustrated by the series of natural size photographs shown in Figures 18-27.

In all of the twenty carbon plates there was no fracturing or shattering of the plate, a fact which shows that they possessed sufficient ductility. However, with the piece of well casing, in which the carbon content was 0.37 per cent, the penetration of the armor-piercing bullet caused the plate to crack. This plate had a Brinell hardness of 515. The fracture is shown in Fig. 26. It is to be noted that one end of the 1/4-inch plate had a Brinell hardness of 555, and although it was tested only with the service bullet, there is no evidence of fracture. Evidently the carbon content has a considerable influence on the action of armor plate when subjected to the fire of the caliber .30 bullet, and it would be of considerable interest to know what effect would be produced on plain carbon heat-treated steels of 0.25 per cent carbon and 0.30 per cent carbon. What the action would be on heat-treated steels of higher carbon content is difficult to predict and tests on them would prove interesting.

IN Table VIII, are recapitulated the chemical, physical and ballistic properties of the untreated and treated steels. The use of this class of steels for matériel which must receive the direct fire of rifles and machine guns at close range is a matter of question. However, there are many classes of matériel, such as tractors and field guns, which do not come within close range of rifle fire, and the

armor of which is designed to afford protection against shrapnel and splinters of shell fragments. For such armor it is believed that the class of steels tested could be substituted for the alloy steels now used. The caliber .30 M 1922 armor-piercing bullet is credited with piercing ¼-inch armor plate at 500 yards range, and ½-inch armor at 100 yards range. The experiments described in this paper did not determine the resistance of the ¼-inch plate at 500 yards. However, the heat-treated ½-inch plate was not tested at 100 yards range with the armor-piercing and service bullets. The plate resisted the service bullet, but was penetrated by the armor-piercing bullet. The result is shown in Fig. 28.

The hull of the Mark VIII tank is built up of armor plates of varying thicknesses. Plates on the sides are 12-mm. thick; those on the front and back 16-mm.; and those on the slopes 6-mm. In service the tank comes within close range of rifle fire, machine gun fire, and the fire of small

TABLE VIII
Properties of Steels Tested

SIZE	CHEMICAL COMPOSITION—PERCENT				QUENCH		PHYSICAL PROPERTIES					BALLASTIC PROPERTIES			
												Penetration Effected at			
Thickness Inch	C	Mn	S	P		Time	Brinell Hardness	Ultimate Strength	Elastic Limit	Elongation	Reduction Area	20 Yards		100 Yards	
					°F	Min.		Lbs. per sq. inch	Lbs. per sq. inch	Percent in 2 ins.	Percent	Service	A. P.	Service	A. P.
1/4	0.22	0.61	0.077	0.018	As received		163	77,300	56,720	15.6	27.0			Yes	
1/4	0.22	0.61	0.077	0.018	1550	30	477 555 340	149,640		Broke Outside	14.0			Yes	
5/16	0.21	0.59	0.055	0.011	As received		163	72,640	51 800	34.3	51.0			Yes	
5/16	0.21	0.59	0.055	0.011	1550	30	477 444 364	124,330		6.2	10.0			Yes	
3/8	0.18	0.57	0.068	0.017	As received		149	66,800	46,090	42.1	44.8			Yes	
3/8	0.18	0.57	0.068	0.017	1600	40	387 228 217	104,770		18.7	38.0		Yes	Yes	
1/2	0.22	0.59	0.051	0.012	As received		170	72 200	48,000	40.6	46.0		Yes	No	Yes
1/2	0.22	0.59	0.051	0.012	1650	40	460 387 387	104,320		17.2	28.0	No	Yes	No	No
5/8	0.24	0.75			As received		170	76,200		36.7	48.8	No	Yes		Yes
5/8	0.24	0.75			1600	40	228 302 269	141,900		7.8	8.4	No	No	No	No
Well Casing 3/8	0.37	0.85	0.029	0.016	1450	30	515 340 415		Not available				Yes	No	Yes

pierced at 100 yards range by the armor-piercing ammunition used.

PLATES ranging in thickness from 0.20-inch to ½-inch are used at the present time as shields for guns and as the protective armor for their caissons. Plates of ¼-inch thickness are used on the artillery tractors. The results of these investigations show that it would be possible to replace some of the alloy steel armor plate with the heat treated low carbon steels. The purpose of a gun shield is primarily to protect the gun and the gun crew from low velocity missiles resulting from the explosion of shells. Tractor armor protects the vital portions of the machinery from the same class of missiles. This matériel may never come under the action of concentrated rifle or machine gun fire at close range. Armor plate for this type of matériel is proof-fired with caliber .30 service bullet at 100 yards, or by some equivalent means, such as firing the same bullet at closer range and with a reduced charge. Much of the armor tested in this manner will not resist the armor-piercing bullet at close ranges. This fact was proved by the test of a piece of ¼-inch tractor armor. This plate was guns of the 37-mm. type. Consequently, the plates of the tank must offer great resistance to penetration, and it has been found necessary to accomplish this by making the plates in the vital portions heavy. The heaviest plate on the tank is but 0.045-inch less in thickness than ⅝-inch. The ⅝-inch heat-treated plate tested in these experiments was not pierced by the armor-piercing bullet at 20 yards range. It is believed that further investigation would bring out a heat-treated low carbon steel plate that would replace some of the tank armor now used.

THE Ordnance Department purchases armor plate from the steel manufacturers on the basis of ballistic properties. If a steel passes the firing test it is accepted, and the Ordnance Department makes no inquiry as to its composition or heat treatment. The exact procedure in the fabrication of armor plate by specific manufacturers is not a matter of public information, but it is known that alloy steels are used, and that they are subjected to heat treatments, some of which are costly and complicated. Heat-treated plain low carbon hot rolled steels are produced in large quantities by the open hearth process. Scrap metals

are used, the labor is not highly skilled, and the product is turned out in large tonnages.

In view of the above statements it is believed that further experimentation on this subject would be justified. For many purposes heat-treated plain low carbon steels could be substituted for the more expensive alloy steels now in general use. Further experimentation should include the investigation of heat-treated steels containing from 0.20 per cent carbon to 0.50 per cent carbon and having the same thickness as those already investigated. There is a standard method for testing light armor ballistically. Time available for this work and the steel obtainable did not permit strict adherance to the method. However, it is believed that the method used approximates the standard method sufficiently closely to warrant the conclusions drawn from the tests conducted. In brief the standard method follows.

Plates of ½-inch or less in thickness should be 12 inches square; plates over ½-inch in thickness should be 18 inches square. The plates should be supported rigidly by a wooden butt, to which they should be bolted or otherwise securely fastened. In the ballistic test of plates of ½-inch or less thickness, the caliber .30 armor-piercing ammunition is used. The cartridges are loaded to give varying velocities to determine the ballistic resistance of the plate. The ballistic resistance is determined by noting the actual striking velocity necessary to penetrate the plate. A sufficient number of rounds of varying striking velocities is fired to determine the penetration velocities within a zone of 25 feet per second. The chronograph is used to measure the velocities of every round fired. The striking velocities may be varied also by changing the distance of the rifle from the plate. However, to prevent abnormal results due to possible instability of the bullets, a minimum distance of ninety feet is prescribed. Impacts should be substantially normal to the face of the plate. A minimum distance of 0.9-inch between the edge of the plate and impacts and between impacts should be maintained. The results are recorded on Ordnance Form 5714. The weapon used is the standard caliber .30 rifle mounted in a machine rest.

AUTHOR'S NOTE: The writer wishes to acknowledge the assistance of officials of the Pacific Coast Steel Company of San Francisco, Calif., who, through the courtesy of their metallurgist, Lieut. L. Anderson, Ord. Res., furnished the steels for this investigation.

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Sweden Mechanizes Her Military Forces

King Gustav V Directs Maneuvers.

This fortress on wheels, with others of similar design, played an important part in the annual Swedish Army maneuvers, November, 1929. The King, despite his seventy-one years, with General Hammarskjoeld, Chief of the General Staff, directed the motorized movement from his position in the field.

Swedish Tanks Execute Movements.

With their engines fore and turrets aft, Sweden's tanks executed difficult maneuvers in the recent military demonstrations before King Gustav. Following the mock battle, the King commended his forces upon the training of their personnel and the efficiency of equipment.

Mausers in History

Characteristics of the Arm Since Its Appearance in 1871

By G. Burling Jarrett*

WITH the history of the world in daily making, by both engines of destruction as well as those of construction, we find a firearm industry in Germany which prepared that nation for more than 60 years against a national emergency, which took the Germans through two wars, the last of which taxed them and the entire world to the utmost.

Since prior to the Franco-Prussian War the Mauser Works at Oberndorff, Germany, have been making military rifles in one of the world's greatest arms plants. Even our Springfield is a copy of a Mauser with many improvements. The majority of the world's military rifles are Mausers or were made under their patents.

A. Mauser, Model 1871, Rifle; B. Mauser, Model 1871, Carbine; C. Mauser, Model 1871-84, Rifle; and D. Mauser, Model 1871-84, Carbine.

In 1871 the first, breech-loading, bolt-action Mauser appeared using a rimmed cartridge, making obsolete the pin-fire Mausers of '68 and '70. The pin-fire piece was developed from experience in the then recent American Civil War and the '71 model from the War with the French. It was 11-mm. in caliber and used black powder. This '71 model was made in both rifle and carbine, and was so well thought of by neighboring powers that a number of rifle plans were changed. The carbine took no bayonet.

Progressively the Mauser works adapted to this piece a magazine, consisting of a tube beneath the barrel, holding 8 cartridges, which by a trap door, or false floor of the receiver, allowed the fresh cartridge to come into position when the bolt was opened and the empty shell ejected. By 1884 this adoption was made and the piece was known as the 71/84 model, caliber 11-mm. with black powder still being propellent. Then Vielle, a French chemist, invented a new powder and also redesigned the French cartridges to utilize the qualities of this powder. The advent of the new powder caused an upheaval in rifle design. With the increased pressures available the French developed a small bore rifle, reducing the caliber of the conventional 11-mm. to 8-mm. and taking advantage of the new powder and its pressure qualities. This was the first small bore military rifle built and the first smokeless or progressive-burning powder. The Austrians also were experimenting at this time, but on a new magazine with the rifle embodying the small bore plan of the French. This work of the Austrians was known as the Mannlicher idea. The experiments of the French and the Austrians took place between 1875 and 1888.

IN 1888 the Mauser Works put on the "military market" the Mauser, model 1888, made under Mannlicher patents, comprising the small bore, smokeless powder principle of the French and the Mannlicher magazine idea. This Mannlicher patent was the first clip-loading magazine and of 5 shots, where the clip became part of the magazine on insertion, being ejected from the bottom of the magazine housing on use of the fifth cartridge.

It is interesting here to note that the United States paid little attention to these experiments, and used a single shot .45 caliber piece until the advent of the Krag in 1898.

However this Mauser found considerable favor. Adaptations of it appear in many European rifles even to this day. It had a novel tubing around the barrel to keep cool for handling, instead of a wooden hand guard just then coming unto use.

It remained the official military rifle of the German Army until 1898 but as early as 1893 the Mauser Works had built a superior weapon. This rifle had the magazine entirely contained in the stock contrary to the Mannlicher idea as seen in the 1888 rifle. In 1895 the pistol grip was added to the stock.

Before discussing this, however, we must not overlook three carbines that appeared between 1891 and 1895, all classed as 1888 models. None was made after '95, nor were the rifles as the newer piece was evidently contemplated. These carbines were novel and will be referred as "a" "b" and "c". "a" was simply a rifle cut down 10½ inches, the bolt handle being slightly bent down. "b" was slightly shorter than "a". The stock came out to the muzzle where the front band did double work and formed a front sight guard, giving the piece a peculiar blunt appearance. This piece had a straight bolt, identical to the rifle. "c" was the same as "b", except that it had a bent-down flat bolt handle and with a stacking piece near the

*Owner, Jarrett Collection of World War Ordnance. Lieut. Ord. Res., U. S. A., Haddonfield, N. J.

A. Mauser, Model 1888, Rifle; B. C. and D. Carbine Models of the Same Year.

muzzle. Neither "b" nor "e" took bayonets, and but few of the "a" and "b" styles were issued.

These model 1888 pieces saw the advent of commercial competitive manufacturing under government supervision, as well as the start of rifle manufacturing in the military arsenals at Danzig and Amberg. Of course the pieces made at the Mauser works also appear among the rifles issued to the using service.

In 1898 arrived the famous Gew. '98, (weapon of '98). Also around this time seems to have appeared the letters D. W. M. (Deutsche Werke Munitions Fabriken). These initials are to be seen on the ammunition as well as the ordnance.

This '98 Mauser appeared up to 1908 in rifle and carbine, both taking bayonets. In 1908, however, the rifle being satisfactory and the carbine not, a new carbine was introduced with the original discontinued. This new carbine followed the idea of the new U. S. Springfield rifle of 1903, a combined rifle and carbine. This new carbine was longer than the former, and is more properly called a short rifle. It was designated by the Germans as "Kar. '98." These carbines were made mostly at the Erfurt Arsenal and with the original rifle now formed the two official military issues of the German Army.

However, 1895, 1896, 1900, '03 and '07 model Mausers made only at the Mauser works at Oberndorff became known only as foreign contract pieces. Many ordnance departments of neighboring countries came exclusively to Germany for their weapons including equipment and Krupp artillery.

These so-called contract pieces are to be noted for there seems to have been an early tie-up between the Mauser people of Germany and the Mannlicher activities of Austria, as we find Mauser weapons being made in Austria and Mannlicher pieces in Germany, as contract weapons for foreign powers, for instance, a Mauser model 1907 rifle made at Steyr, Austria, for Mexico.

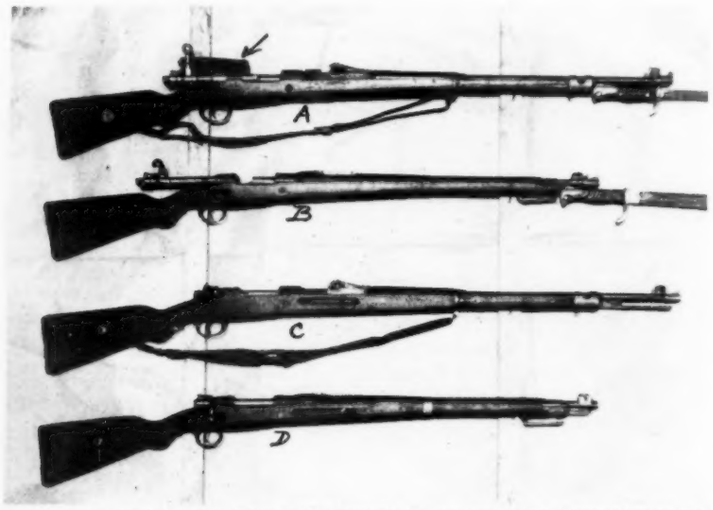
There were many different calibers yet a remarkable amount of interchangeability among these contract Mausers. With the World War at hand many hundreds of these weapons, then undelivered, simply had model 1898 barrels fitted to their receivers and were consequently available for military use of the Germans. It is to be remembered that all rifles made under Mauser patents from 1893 to 1907 had the same bolt head and the bases of their respective cartridges were the same, irrespective of their side walls and necks, so that only a barrel change was necessary. With the average length of all the cartridges the same, slight or no change was necessary in the receivers.

Again it is to be remembered that the regulation issue of the German Army was the 1898 model Mauser, and no changes appeared in this arm from 1908, already discussed, until 1916, when a hole with bushing was added to the butts. This change had a double purpose: to fasten the piece in the shipping boxes and to permit the insertion of a pocket periscope in the leg. By inverting the rifle one might peer over the trench parapet.

Early in 1917 finger slots appeared beneath the rear sights in the stocks of both rifle and carbine as an aid to the marksman. The holes in the butts were continued. From 1915 to 1918 saw some of the '98 rifles equipped with attachable front and rear illuminating sights for night firing, accomplished by the use of radium.

Continuing, we find six patterns of telescope mountings, screwed to the receivers. Apparently several optical companies made the sights. The Zeiss seemed to have had three styles. A seventh pattern was a bifocal telescope attached to the regular rear sight by clamps, and a special front sight snapped on over the regular front sight of the rifle not unlike our own Springfield sight cover. Many of these sniping rifles had 20 shot magazines, attached by removing the regular magazine floor plates.

There was one other sniping rifle with a stock extension which made possible the operation of the piece over the trench parapet with the gunner completely out of sight.



A. Mauser, Model 1898, Rifle with Breech Cover and Bolt Opened, Bayonet Attached; B. Same Rifle with Bayonet Attached; C. Same Model as A but Made after December, 1916—Note Butt and Eyepiece; D. Carbine Made after December, 1916.

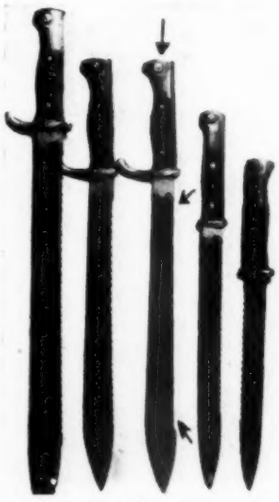
During the war at least five commercial companies are known to have made '98 Mausers. They are as follows:

C. G. Harvel	SUHL
V. Chr. Schilling	SUHL
Simson & Co.	SUHL
J. P. Sauer & Son	SUHL
Loewe	SUHL

In addition were the two government factories: Waffenfabrike Mauser, A. G., Oberndorff, and Deutsche Werke und Munitions Fabriken, Berlin, and the four military arsenals: Danzig, Erfurt, Amberg and Spandau.

Further we see an 1898 Mauser drill rifle which is simply a solid, cast receiver with a pipe for a barrel. Outward appearance is that of a regular 1898 rifle, but no working parts.

Two '98 model rifles appear as grenade-throwing rifles, one was partly bored out and used a stem grenade; the other had a muzzle cup attached and shot a grenade similar to our own type, by lodging a bullet in the grenade after firing a service cartridge.

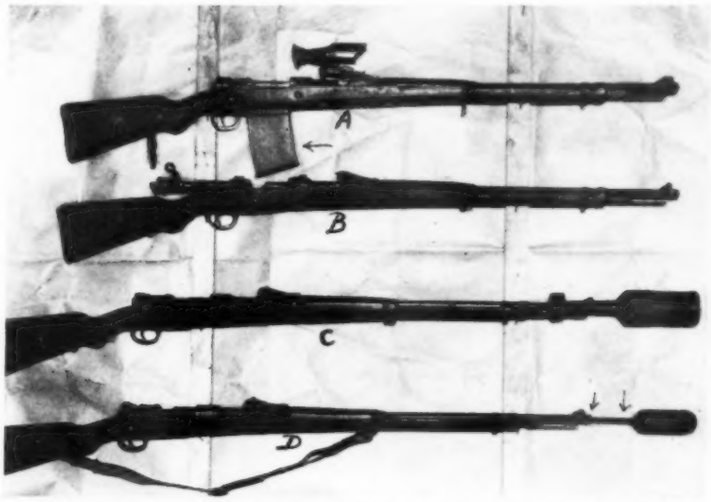


Several Models of Sawedge Bayonets; Center: A Ground-off Specimen.

PROBABLY the greatest achievement of the Mauser works at Oberndorff was the Mauser, Model 1918, the famous antitank rifle, caliber 13-mm. This piece was the result of considerable experiment with both ammunition and design of the gun. It was a necessity occasioned by the advent of the British tank and as a means of stopping this new feature of the greatest of wars.

First a bullet must be designed that would be of such caliber, plus velocity, that could penetrate tank armor; secondly, the piece that expended such ammunition must be portable. The projectile was designed and the rifle followed. The bullet developed about 2700 f.s., the gun was sighted from 100 to 500 meters and was found to function satisfactorily. It was most powerful, naturally, at the 100 meter range. This distance was precarious to the gunner if the tank driver spotted him, however.

The bullet penetrated up to 30 degrees from the vertical point of impact and consisted of a copper jacket to protect the rifling, and an inner lead lining to act as a lubricant during penetration, and also to make a non-skid effect during impact. The inner core was of high-grade tool steel and turned to a sharp point. The assembled bullet was boat tailed and seated in a semirimmed cartridge, not unlike the 8-mm. Mauser cartridge.



A. Sniping Model, 1898, Equipped with Bi-focal Zeiss Telescope and 20-shot Magazine; B. Model 1898, Sniping, with Attachment Blocks for Regular Telescopic Sight; C. Grenadier Model, 1898, with Grenade Cup Attached; D. Same, with Stem Grenade Inserted.

The appearance of the rifle on the western front caused trouble for the British and necessitated additional tank armor, as casualties among the pilots became increasingly large.

This rifle weighs 30 lbs., is 5½ feet long, and is fired from a bipod rest. There is a pistol grip attachment on the stock to aid in holding the piece during firing. It was usually fired with the gunner lying prone, the recoil is not as severe as might be expected.

Having mentioned this type, we find the discussion of the true Mauser patent pieces about completed, yet we must not neglect the arms captured by Germany and altered for her own use.

It will be interesting to note in this connection that, not withstanding the immense resources of the German arms factories, the enormous demands of war practically had exhausted their capacity to produce additional weapons owing to scarcity of the necessary materials. So that they turned to captured arms for replacements. Many thousands were so altered.

The French and Russian rifles had sleeves added to the

A. Model 1917 Mauser Rifle, the "Contract Mauser" Specimen; B. French Rifle with Regulation Bayonet Attached; C. Same as B but after Alterations and with German Bayonet Attached; D. Belgian Carbine with Special Saw Bayonet for that Piece, Fixed.

muzzles and were thereby able to use German bayonets. The higher commanders of the German Army disliked the four-edged bayonets of the French and Russian rifles, hence this alteration.

As to the captured Belgian rifles, their own bayonet was considered satisfactory and no alterations were made to these pieces. But, they did make a special saw-edge bayonet for this rifle, which did not fit any German rifle.

Some of these altered rifles were in use in the latter days of the war, and not uncommon was a lot of captured ammunition used up in the respective rifle. The Germans even went so far as to manufacture ammunition for the captured arms although it is doubted if very much was ever issued to the troops. Ammunition was also made by the Allies for German rifles as a precautionary measure.

IT might be interesting to add a word about the much talked of German saw-edge bayonet. Eleven types were made, ranging from 8 to 21 inches in blade length, the length of the actual teeth surface varying from 6 to 14 inches. On all these blades there was a smooth edge at the point. Contrary to general belief, a double row of teeth was ground so as to project towards the tip of the blade. When fixed to the rifle, the cutting or tearing is with a forward thrust. As a result this weapon is not efficient for bayonet fighting. Nevertheless there were many times that the saw-toothed bayonet was used by German troops for bayonet work. It was, however, not designed as a barbarous implement by the German Government but to combine saw and bayonet for pioneer troops. Every pioneer trooper was issued one, and *one* man in every infantry squad was alike issued one. With the regular infantry, this weapon was to serve in aiding the squad through brush and wire entanglements.

Stories are so often heard of the easy thrust of such a bayonet and the disembowelment of the victim on the retrieve, but such is not possible, as explained above. The statements made about these bayonets have not been made through favor, but from research on them and generally on German ordnance by the writer.

Further, we find proof of these statements in the fact that in 1918 Germany, due to a general bayonet shortage for infantry issue, when a blade of any character was fitted up for the troops, ground off all the saw-edge blades in stock for the infantry, and issued them. The usual German proof marks appear on the newly ground surfaces, which stamp them official. Summing up, we find Germany used 38 kinds of rifles, of which 34 were Mausers, 3 French and 1 Russian. Of the 34, 2 were Belgian Mausers and the balance true German Mausers, of various patterns. Of these 34 pieces, 8 were converted for sniping purposes and 2 for grenade use.

In this entire German Mauser group, but 2 types of cartridges are found. The 11-mm. and the 7.9-mm. (8-mm.) The former was in use from 1871 to 1887; the latter with ballistic changes from then even to this day.

The pieces discussed in this article may all be found in a collection of modern military firearms representative of other nations as well as Germany, collected by the author at Haddonfield, N. J. The author extends a cordial invitation to all interested persons to inspect the collection. Inquiries should be sent to the above address.

General Williams Urges Mechanized Development

MAJ. GEN. C. C. WILLIAMS, Chief of Ordnance, U. S. Army, appearing before the Appropriations Committee of the House of Representatives during the recent hearings on the War Department appropriations bill, explained in detail several developmental projects relating to mechanization of the Army for which additional funds were requested. In response to inquiries of Representative Barbour, General Williams said:

"Let us take, first, the 37-mm. semiautomatic gun. The gun with which the old tanks are equipped, the 37-mm., is not a semiautomatic gun. It is a single-fire weapon, and each round has to be inserted separately, which means that you can not get the rapidity of fire that you get with the semiautomatic. The semiautomatic 37-mm., as developed by Mr. John Browning, you remember, fires a clip. You insert a clip of five cartridges, and all you do is pull the trigger.

"The next item is the 75-mm. self-propelled mount, $55 000. With respect to that, I think I should say that right after the war the Ordnance Department took up the question of self-propelled mounts for various calibers of artillery, working with the Holt Co. Mr. Pliny Holt, of the Holt Co. of Stockton, had been with us during the war, and he worked with us in developing a number of these self-propelled mounts. These self-propelled mounts then manufactured were tested out by the using services, and they thought that we had too many eggs in one basket, when we had the gun mounted right on top of the power plant, so to speak. They preferred to have the power plant separate; in other words, to have the power plant in the form of a tractor rather than have the gun itself mounted right on top of the tractor. So the development of those self-propelled mounts was then stopped.

"The mechanized unit again brings up the question of the self-propelled mount, because it has greater mobility if mounted right on the piece itself. It handles a little more easily. You can go into action and out of action more quickly. If you are going to have a 75-mm. gun mounted so as to form a part of a mechanized unit, the self-propelled mount is the best way to do it. Therefore we want to take our old designs, and see what there is useful about them, because several years have passed now. We want to design a new self-propelled mount that would fit in properly with the mechanized unit.

"The same statement applies to the 75-mm. self-propelled caisson.

"The next item is the cross-country vehicle mounting for the caliber .50 antiaircraft gun. One of the things we are constantly working at is to find a method of giving protection to a marching column; that is, protection from aircraft. That protection, of course, has got to be ready for use instantly. If an airplane is sweeping down on you, you can not take five minutes to get ready to fire at it, because by that time it is gone. You have to have a man at whatever weapon it is you are going to use, and be able to turn it the instant the target comes in sight, and commence to use it. It is that kind of a mount for the caliber .50 gun that we would want to provide for this mechanized unit.

"The next item is the Christie armored car, $40,000, which I think would be proved if we procured the four or five I recommended to you."

U. S. Army Ordnance

Extracts from Annual Report of Maj. Gen. C. C. Williams for 1929

THE Ordnance Specialists' School, located at the Raritan Arsenal, N. J., is primarily for the instruction of officers and enlisted men in Ordnance Field Service work. During the past school year 11 officers, 216 enlisted men and 1 reserve officer of the Army, and 10 chief petty officers of the Navy received instruction at this school.

One hundred and forty-nine enlisted men of the Ordnance Department attended the specialists' courses at the school. The Department has always experienced considerable difficulty in obtaining the desired number of enlisted men for training because the shortage of enlisted men is so acute that a majority of the men with organizations can not be spared for long periods for training purposes. Steps were, therefore, taken to obtain 107 recruits from The Adjutant General. The majority of these men have been sent to foreign service upon completion of the school courses. Specialists' courses are of nine months' duration and train enlisted men as armorers, blacksmiths, clerks, electricians, equipment repairmen, machinists, artillery machinists, auto mechanics, munition workers, sheet metal workers and welders.

One officer was detailed at the plant of the Caterpillar Tractor Company, San Leandro, California, and three were detailed to study production engineering with various commercial plants. This is considered most valuable training for officers whose services will be utilized in connection with procurement planning or with manufacturing.

Four officers of the Department attended the regular course at the Harvard Graduate School of Business Administration. Units of the Reserve Officers' Training Corps were maintained at the following institutions: Cornell University, Georgia School of Technology, Massachusetts Institute of Technology, University of California, University of Cincinnati, University of Michigan, Leland Stanford University and Lehigh University. Arrangements have been completed for the installation of a new unit at the University of Washington. The total enrollment in the advanced course was 392. Existing limitation on enrollment seriously affected several Ordnance units. If it were possible to remove this limitation, many additional students could be trained as reserve officers without increased expense for overhead.

During the year 332 reserve officers were trained at the various ordnance establishments. Every effort is being made to train each reserve officer for the duties which he will be called upon to perform in the event of mobilization. Each officer first receives a basic course which is applicable to all officers of the Department, and thereafter the special training which is required for his particular assignment.

DURING the past year war-planning activities have been reorganized to comply fully with the principle of decentralization. As now organized, each operating division of the Office of the Chief of Ordnance conducts its own war-planning activities, subject to supervision and coördination by the War Planning Section of the chief of the group to which it belongs and by the War Plans Division, which latter has responsibility for the supervision and coordination of the work as a whole. This organization accomplishes two things: the detailed mobilization and procurement plans are prepared by the unit which will be charged with their execution in time of emergency, and, war planning is closely allied with current activities which is particularly essential in the case of technical items.

A study has been completed revising the essential item list and the wastage and consumption factors.

A pamphlet has been prepared on Ordnance War Planning which describes the organization, prescribes the functions of all units, and outlines detailed procedure to be followed in the preparation of all mobilization plans, both general and special. In this pamphlet have been incorporated instructions to corps area ordnance officers with a view to making their mobilization plan annexes uniform, in so far as such instructions do not conflict with the instructions of their respective corps area commanders. This pamphlet combines in convenient form all instructions regarding war planning, except detailed instructions for procurement planning which are of too specific a nature to be incorporated in a directive of this character. Detailed instructions for procurement planning are published in procurement policy bulletins issued by the Chief of Manufacture.

No change has been made in procurement plans during the past year, and the basis of these plans continues to be the 1924-General Mobilization Plan. Work has continued in the formulation of plans for the procurement of strategic raw materials in the event of emergency and in this phase of procurement planning, as in that for fabricated items, the assistance of recognized civilian experts has been freely given and has proved of the greatest value. The preparation of plans for the procurement of ordnance matériel, under the direction of the Assistant Secretary of War and through the medium of the Ordnance District Offices, has continued during the year and substantial progress has been made. In the preparation of procurement plans recourse is had to the personnel of the procurement districts, the manufacturing arsenals, ordnance reserve officers and civilians, all of whom have rendered material assistance, without which the assurance of adequate production in an emergency would be materially decreased. The civilian committee organized for the purpose of assisting the Ordnance Department in its plans for the production of artillery ammunition continues to be of the greatest value to the Department, and the formation of similar committees with respect to other types of ordnance matériel is contemplated. The preparation of type plans for the manufacture of ordnance matériel is being continued. These plans will be of great value to industrial facilities in the preparation of their factory plans for emergency production.

After extended study, a revision in the method of computing requirements and in the procurement of parts, accessories and equipment has been made which will greatly

simplify and expedite war planning for these items. Plans have been revised for the overhaul of unserviceable stocks on hand.

THE development of a suitable semiautomatic shoulder rifle, ultimately to replace the Springfield magazine rifle, model 1903, as the arm of the individual soldier, is rapidly approaching completion. The design of a suitable semiautomatic rifle within a practicable limit of weight, that is, to be no heavier than the present service rifle, resulted in the development of a weapon of that type of a caliber smaller than that now used. The reduced-caliber weapon proved so satisfactory that twenty rifles of this type were manufactured for test by the Infantry and the Cavalry.

This test was completed, with favorable results, in 1928 and a board of officers was appointed by the War Department to consider the subject of a suitable caliber for the new service rifle, and to submit recommendations for a change, should one be found advisable. This board concluded its considerations during the summer of 1928, and recommended that a caliber of 0.276-inch be adopted for the future development of a service rifle of the semiautomatic type, to replace the present service rifle. This recommendation was approved by the War Department, and July, 1929, was set as the date for a competitive test of semiautomatic rifles which may be submitted by interested designers.*

A new aircraft machine gun, caliber .30, has been completed and tested by the Ordnance Department and the Air Corps, with satisfactory results. The new weapon is much lighter than the caliber .30 aircraft machine gun of synchronized type now in use, and will replace both the synchronized and flexible guns at present standard for the Air Corps. The new weapon was developed and manufactured by a commercial concern under contract with the Ordnance Department. A contract has been placed for the manufacture of 325 of these guns for the Army and for the Navy.

A new type of tripod for the caliber .50 antiaircraft machine gun, recently standardized, has been supplied to antiaircraft units.

A wheeled gun mount, designed to carry the caliber .30 infantry machine gun and tripod, which was developed and supplied to the Infantry for service test during the early part of 1928, has been tested by the Infantry, with satisfactory results, and this item has been standardized. It will enable the infantry machine gun to be transported in such manner as to be instantly available against aircraft at all times.

The 75-mm. subcaliber mount T4 for 14-inch railway matériel has been modified to provide a blast shield for the protection of the manning detail. If this device proves satisfactory, two additional units will be manufactured and issued to the battery in Panama.

Seventeen of the 23 subcaliber mounts authorized by the Secretary of War for major caliber seacoast artillery have been completed and issued to the service. Funds are available for the construction of the remaining units as soon as the service tests of pilot types have been completed.

A BATTERY of 3-inch antiaircraft gun mounts M1, and one 3-inch antiaircraft mount T1 were tested during the 1928 antiaircraft exercises. The performance of the battery was on the whole very satisfactory, and little need for further improvement was indicated. At the completion of the exercises the battery was issued to the Coast Artillery. After a period of service use, minor defects developed in the firing lock and certain parts of the running gear which since have been corrected. Six new units are now under construction at the Watertown Arsenal, Mass. Considerable difficulty has been experienced in securing satisfactory steel castings for certain parts of the carriage, and, as a result, the Arsenal is now experimenting with a cast alloy of aluminum and welded construction. Preliminary tests indicated that the welded parts will be entirely satisfactory, and that practically all steel castings can be eliminated.

The battery of two 105-mm. antiaircraft guns, on fixed mounts, was subjected to further tests during the 1928 antiaircraft exercises. The torque amplifier equipment purchased from the Sperry Gyroscope Company was satisfactory from a mechanical standpoint, but was somewhat under-powered for the 105-mm. carriage. It is planned to install the amplifier on two 3-inch carriages for further test during the next exercises. Defects noted in the tests of the pilot carriages have been corrected, and it is expected that the two new units under construction at Watertown Arsenal will represent fully developed matériel, suitable for issue to the service.

Investigation of the antiaircraft height finder was continued during the year, with a 5-meter base coincident height finder purchased from the Levallois Company and a 4-meter stereoscopic instrument purchased from the Zeiss Company. The latter instrument is the best tested to date, but still does not possess the required degree of accuracy. Specifications covering an 8-meter base height finder have been prepared and submitted to the principal manufacturers of optical instruments in this country and abroad.

The 3-inch antiaircraft fixed and mobile guns have been redesigned to provide greater clearances between removable liners and tubes, and adequate manufacturing tolerances. These changes have resulted in an increase in the weight of the liner and a slight increase in the weight and exterior dimensions of the assembled gun. These disadvantages, however, are more than offset by the improvement in design from a manufacturing standpoint and by making the liners truly interchangeable. The new designs have been standardized, and several units of each type are now under manufacture.

The breech mechanism of the 37-mm. infantry gun has been modified by substituting a spring-operated firing lock, for the hammer type mechanisms which proved unsatisfactory in service tests by the Infantry Board at Fort Benning, Georgia. Preliminary studies have been prepared of a 6-inch high-velocity sea-coast defense weapon designed for mounting on a barbette carriage.

With a view to the further development of the centrifugally cast gun, a program has been adopted which covers the manufacture and test of a number of cannon, of various

*Editor's Note: Since the preparation of General Williams' report, and as announced in the November-December issue of ARMY ORDNANCE, the board appointed to conduct the competitive test has recommended that the Garand and Pederson semiautomatic rifles, developed under the direction of the Ordnance Department, be subjected to further service test. Upon completion of such tests a final recommendation as to the semiautomatic rifle to be adopted for the Army will be made.

calibers, constructed by this process. The calibers included in the program range from 37-mm. to 105-mm., as well as the 3-inch antiaircraft guns. Where practicable, these cannon will be equipped with simple and inexpensive breech mechanisms, as it is intended to fire to destruction the first two cannon of each caliber manufactured. One of these cannon, namely, the 75-mm. mortar T3, has already been tested with very high pressures, and has given satisfactory results.

FOUR complete units of 75-mm. pack howitzer matériel have been under test at Fort Robinson, Neb., during the year. Two of these units have been withdrawn from service and will shortly be replaced by two new units, designated M1, which are practically completed. Twelve additional pack howitzers are now under manufacture. Pack load accessories have been redesigned to conform to the Phillips pack saddle, which was approved and adopted as standard.

Six units of 105-mm. howitzer carriage M1 are under manufacture at the Rock Island Arsenal, Ill., and will shortly be completed. These six units, together with the two model T2 units now at Fort Bragg, North Carolina, will constitute two batteries of this matériel which will be available for service test. Four additional units are to be manufactured during the coming fiscal year.

Tests of the tubular type of recoil mechanisms for 75-mm. gun matériel have been continued, and it is expected to issue two of these mechanisms with the four 75-mm. gun units above mentioned to be returned to Fort Sill, Oklahoma, for completion of service test. Work on metallic packing development is being continued. Extended service tests indicate that some of the designs will probably be satisfactory.

DESIGN and development work during the year has been centered upon the light tank T1E2 and the medium tank T1. The design of the medium tank has been approved and contract has been entered into for the manufacture of one pilot. Based upon extended tests of the light tank T1E1 by the using service and by the Ordnance Department, a design to incorporate all changes recommended was completed, and a light tank, designated T1E2, has been manufactured. This tank is of greatly increased power. Shop test at the manufacturer's plant has been initiated, and it is expected that the vehicle will shortly be ready for shipment to the Tank Board at Fort George G. Meade, Maryland, for service test.

Efforts, in coöperation with commercial industry, to develop a satisfactory tank compass have not been successful. Work on this problem is being continued. The smoke-screen apparatus for the 6-ton Tank M1917 was tested by the using service, and further development was requested. The Chemical Warfare Service is now working on the development of a type to incorporate the changes requested for further test with the new type of light tank.

Experimental firings in connection with the investigation of thin armor plate have been continued at the Aberdeen Proving Ground and in the laboratory at the Watertown Arsenal. Samples of commercial plate have been received from the Carnegie Steel Company and tested. The results have been gratifying and indicate that plate of considerably greater resisting power has been developed.

Four medium and two light armored cars, employing commercial automobile chassis, have been completed and have undergone an extended test with the mechanized force at Fort George G. Meade, Maryland. These cars were then transferred, under their own power, to the First Cavalry Division at Fort Bliss, Texas. Reports indicate that the medium cars have given highly satisfactory service, but that the light cars are not sufficiently rugged to withstand the severe service met with over that terrain.

Tests of various types of commercial tractors have been carried forward during the year. Test of the Caterpillar "20", "30" and "60", the Monarch, and the International Harvester tractors, equipped with half track-laying adapters, was continued by the Ordnance Department and the various service boards. A new model of tractor, the Caterpillar "10," was procured for use by the 34th Infantry Regiment which has been experimentally motorized during the past year. All tests indicate that commercial industry is constantly improving its product, and that the requirements of the Army will be satisfactorily met by the use of these tractors. A satisfactory pintle has been developed and standardized for use on all prime movers.

The experimental mechanized forces assembled at Fort George G. Meade during the year had available for test two motor carriages for the 75-mm gun M1916, and one motor carriage for the 155-mm. 8-inch howitzer M1920. The work of reconditioning the two motor carriages for the 75-mm. gun M1916 is now under way. One of these motor carriages will be shipped to Fort Sill, and the other to Fort Benning, Georgia, for test.

Twenty-three cross-country cars were available in connection with the maneuvers of the mechanized force at Fort George G. Meade. Performance of these cars was generally satisfactory. During the year the 34th Infantry Regiment (motorized) has been furnished with five light standard commercial touring cars, and with 18 light commercial touring cars modified to use a larger size balloon tire. Comparative tests of the two types will thus be available.

Various types of tracks and suspensions have been designed and tested in the constant effort to improve these components of high-speed track-laying vehicles.

THE question of using high tensile alloy cast iron shell as a substitute for forged steel shell was under investigation. Four different lots of 75-mm. shell, of different alloys, were manufactured, and were subjected to metallurgical and fragmentation tests. So far as strength is concerned, the shell proved satisfactory, but in the fragmentation test they gave the characteristic cast-iron or semi-steel results in that the fragments were too small to be effective. Twenty-five containers were manufactured by a commercial concern using the electric contact welding process.

Manufacture of the 3-inch antiaircraft shell Mk IX from seamless drawn steel tubing is proceeding satisfactorily. Considerable difficulty was encountered in satisfactorily closing in the base end, but this has been overcome, and manufacture by this process has proven practical. A small lot of these shell was made by a commercial concern using the electric contact welding process. Metallurgically these shell were satisfactory, but they did not fragment as well

as the standard shell. Arrangements have been made to obtain an additional lot, with the grain of the metal perpendicular to that of the first lot, for further test. The use of gilding metal, instead of copper, has been found to be a great improvement in reducing metal fouling in the 3-inch and 105-mm. antiaircraft guns, and all new ammunition for these guns will be provided with projectiles having gilding metal rotating bands for more extensive tests, before adopting this material as standard.

A study made of the method of manufacturing smokeless powder indicates that it will probably be practicable to reduce materially the time required for the purification of nitrocellulose without any sacrifice of stability, and with great economy in the consumption of water and steam used in the process. Experiments in the manufacture of smokeless powder from purified wood cellulose, now available in large quantities, have demonstrated that this material may be regarded as a satisfactory substitute for purified cotton linters. A standard method has been adopted for determining the viscosity of cellulose and an informal agreement has been reached with the Navy leading to the adoption of uniform specifications for all of the ingredients of smokeless powder.

Work has been continued during the year on determining more accurately the resistance functions of the various types of projectiles. In connection with this investigation, the resistance functions of proof slugs were determined, for use in correcting measured instrumental velocities to muzzle velocities. It was found that a more uniform shape of the front end of the proof slugs should be required and drawings have been revised accordingly. Resistance functions are also being obtained on two types of projectiles, namely, the 75-mm. Mark IV (a stream-line type), and the 3-inch 15-pdr. (a square-base type).

ON July 1, 1928, all captured German World War trophies then in storage depots reverted by law to the jurisdiction of the War Department and distribution to the States ceased. This matériel is now classified as obsolete, and is being donated, in accordance with existing law, to municipalities, veterans' organizations, museums, etc., for display purposes. A large number of German trophies have been donated in accordance with the foregoing, while a considerable number, other than field pieces, still remain available for donation. This matériel is now stored at the Raritan Arsenal.

The acts approved May 29, 1928, and March 4, 1929, carried appropriations of $1,914,161.00 and $1,050,403.00, respectively, for the improvement of ammunition storage facilities of the Army, in accordance with the recommendations of the Joint Army and Navy Board appointed to study this subject. Under the provisions of these acts 466.2 acres of land have been acquired at the Nansemond Ordnance Depot, Va., to provide a protective area, the purpose of which is to prevent encroachment of civilian activities which would be subject to possible hazards originating at an ammunition depot. At the Ogden Ordnance Depot, Utah, options have been obtained on 200 acres of land, and condemnation proceedings have been instituted with a view to acquiring 360 acres additional. Land has been acquired at the Benicia Arsenal, Calif., for the erection of magazines and to provide a protective area through the exchange of a right-of-way through the arsenal grounds to the Southern Pacific Railroad in return for the land required.

Sixteen additional magazines for the storage of high explosives and bombs are under construction at the Aberdeen Proving Ground, twenty-four at the Savanna Ordnance Depot, Ill., and four at the Benicia Arsenal. Five other magazines are being erected at the Benicia Arsenal for the storage of miscellaneous ammunition. The repairs of existing magazines and railroads provided by this legislation are nearing completion.

The acts above cited also provide for the removal from the Raritan Arsenal, and the Curtis Bay Ordnance Depot, of all separate-loading high-explosive shell, as well as bombs, and bulk high explosives. The projectiles have been transferred, and the bombs and high explosives will be transferred as soon as the new magazines are ready for their reception. A very extensive program of restorage within the depots is now under way, having as its object the elimination of danger by proper segregation of different types of ammunition; by eliminating overloaded magazines; and by the maintenance of necessary safety distances to inhabited buildings, railroads and public highways. About one-third of the contemplated restorage has been completed.

Ammunition storage facilities are also in contemplation for the Panama, Hawaiian, and Philippine Departments, and at Fort Bragg, North Carolina. Construction at Panama is well under way. The original project for construction in the Hawaiian Department was quite extensive providing for harbor defense and post storage as well as for the establishment of an extensive depot for war reserve stocks. The Second Deficiency Act, approved March 4, 1929, suspended temporarily the provision for the war reserve storage depot. The magazines required for post and harbor defense storage are under construction.

In the light of past experience, it is confidently expected that after the projects referred to in the preceding paragraphs shall have been completed, probability of injury to persons or damage to property outside of the ammunition depots in the event of fire or explosion will be practically eliminated.

California Post A. O. A., Awards Marksmanship Trophies

THE California Post of the Army Ordnance Association recently presented to the Ordnance R. O. T. C. Unit of the University of California two marksmanship trophies consisting of a silver trophy cup and a regulation officer's saber through the kindness and generosity of Capt. H. P. Witten, Ord. Res., Stockton, Calif., who defrayed the expenses involved. These trophies are to be presented each year to the Ordnance Cadet making the highest score in the annual Inter-R. O. T. C. Unit Gallery Rifle Competition at the University of California. The cup is a perpetual trophy with the name of each year's winner inscribed thereon and remains in the possession of the Ordnance Unit. The saber presented each year becomes the permanent possession of the winner.

The 1929 winner of these trophies is Cadet Technical Sergeant George E. Sweeney of San Francisco. The presentation was made by Lieut. Col. C. F. Wieland, Ord. Res., of Berkeley, a member of the California Post, at a University of California R. O. T. C. review on November 21, 1929.

With Foreign Armies

A Salute To The Tiger of France.

Guns stationed along the banks of the Seine in Paris firing a salute to M. Georges Clemenceau, French War leader, at the moment his body was buried in a forest at Mouchamps in his native Vendee.

Poland's Eleventh Anniversary of Independence.

Batteries of Polish machine gunners passing in review before Marshal Pilsudski, seen in the reviewing stand on Pilsudski Square, Warsaw. The review was part of the celebration commemorating the eleventh anniversary of Poland's independence, December, 1929.

U. S. Naval Ordnance

Extracts from Annual Report of Rear Adm. W. D. Leahy for 1929

FUNDS were appropriated and allotted for the fiscal year 1929, as follows:

Act of May 21, 1928:	
Ordnance and ordnance stores	$11,952,050
Purchase and manufacture of smokeless powder	1,000,000
Torpedoes and appliances	450,000
Civilian employees of the bureau	144,440
Increase of the Navy, armor, armament, and ammunition	16,500,000
Alloted from major alterations to naval vessels (*Oklahoma* and *Nevada*)	1,798,000
Act of Mar. 2, 1929:	
Increase of the Navy, armor, armament, and ammunition	200,000
Act of Mar. 4, 1929:	
Ordnance and ordnance stores	37,400
Civilian employees of the bureau	10,200
Allotted from major alterations, naval vessels (*Pennsylvania* and *Arizona*)	1,750,000
Total	$33,842,090

During the year there was completed a classification and indexing of all United States patent abstracts relating to ordnance inventions for the period of 1917 to 1927. This includes the large volume of ideas stimulated by the World War and the experience derived from actual hostilities. After an extended series of conferences with the Army and other Government departments, with the purpose of preserving the secrecy of inventions relating to the national defense, a modification of existing legislation was arrived at which if enacted will materially improve the situation regarding this vital matter.

The need for a technician experienced in ordnance matters and capable of preparing patent drawings and patent specifications is still actively felt.

Encouraging progress has been made in clarifying the status which exists between the Government and an employee in relation to the Government's equity in patents made by employees. This bureau expended $11,180 by authority of the beneficial suggestion act to employees who made beneficial suggestions or inventions of great value. Extensive investigational work has been performed by the bureau for both the State Department and the Department of Justice in connection with the settlement of war claims arising out of patents seized by the Alien Property Custodian.

A 5-INCH antiaircraft battery has been installed on the *Tennessee*. Five-inch antiaircraft batteries have been completed and shipped to the *Oklahoma*, *Nevada*, and *California*. The work on 8-inch and 5-inch batteries for cruisers *Nos. 26* to *31* is progressing at a satisfactory rate and partial shipments have been made to the three cruisers scheduled to be completed in 1930. Orders for forgings, and finished guns for cruisers *Nos. 32* to *36* have been placed. Forgings are being supplied by the Bethlehem Steel Co., the Midvale Co., and the Erie Forge Co. Eight-inch guns are to be manufactured by the Naval Gun Factory, Watervliet Arsenal, and the Midvale Co. All 5-inch guns will be manufactured at the Naval Gun Factory. A replacement 16-inch battery for regunning the *Maryland* has been delivered at Puget Sound. The secondary battery on the *Maryland* has been regunned and replacement secondary batteries for battleships to be regunned during the ensuing year have been provided. The necessary arrangements have been made for regunning the batteries of destroyer division 38 prior to its departure for Asiatic duty. Congestion in large gun stowage at the Naval Gun Factory is being relieved by moving certain guns to the naval proving ground. The actual transfer of all 12-inch and 8-inch guns and breech mechanisms held for the United States Army has been accomplished, except four 12-inch guns now in storage at Mare Island. These will be transferred to the custody of the Army in the next fiscal year. Eighteen 8-inch 55-caliber guns were manufactured at the Naval Gun Factory and in addition seven 8-inch 55-caliber guns from Watervliet Arsenal and two 8-inch 55-caliber guns from the Midvale Co. were fitted with breech mechanisms and completed at the Naval Gun Factory, making a total of twenty-seven 8-inch 55-caliber guns completed. Twenty-four new 5-inch antiaircraft guns were also completed during the year. In addition, the Naval Gun Factory lined, relined, or modified guns as follows: One 16-inch 45-caliber, fifteen 14-inch 50-caliber, six 14-inch 45-caliber, seventy-seven 5-inch 51-caliber, three 4-inch 50-caliber, and one 3-inch 50-caliber.

FIVE-INCH 25-caliber antiaircraft mounts have performed successfully during the past year. Reports from ships indicate only minor difficulties, which will be overcome by modification in new construction. Five-inch antiaircraft mounts were manufactured and delivered during the fiscal year, as follows: Eight each to the *California*, *Oklahoma*, and *Nevada*, four each to the *Salt Lake City*, *Pensacola*, and *Northampton*. Deliveries are expected to be made by January 1, 1930, to the *Chester*, *Houston*, *Louisville*, *Chicago*, and *Augusta*. Orders have been placed for eight each for cruisers *Nos. 32* to *36*, inclusive, and for aircraft carrier *No. 4*.

Manufacture of parts for turret and broadside mounts and sights for the *Oklahoma* and *Nevada* has been completed and for the *Pennsylvania* and *Arizona* has been authorized and work started. Conversion of 32 Mark XXI sights for the *New York* and *Texas* to the Mark XXI Mod. 2 sight has been authorized and work started. It is expected to complete this work prior to January 1, 1930.

A new design of foot-firing mechanism for the 4-inch wet-type mount has been completed. It is expected to make delivery to all submarines prior to March 1, 1930. Six-inch mounts for the *V-5* and *V-6* have been modified to reduce weight.

CALIBER .50 single and twin antiaircraft machine-gun mounts after modification have been sent to ships for test. A new design of single mount has been completed, and it is expected that this type mount will be manufactured prior to March 1, 1930. The installation of caliber .30 and caliber .50 antiaircraft mounts on battleships and cruisers has been deferred until definite reports have been received from the fleet concerning the experimental firing of the caliber .30 and caliber .50 antiaircraft machine guns.

Information obtained from the late test firings of modified caliber .50 machine guns indicates that a decided improvement over the old type can be expected. The parts necessary to modify old guns now on hand have been ordered and deliveries are expected by September 1, 1929. These parts will be installed immediately upon receipt.

No armor was manufactured during the past year. In connection with the ballistic tests of special-treatment steel plating for light cruisers *Nos 29* to *31* tests have been made in coöperation with the Bureau of Construction and Repair of various types of riveting, plate connections, welding, gratings, and hatches.

During the past year contracts were placed with the Crucible Steel Co. of America and the Tredegar Co. for projectiles. Test firings of 8-inch projectiles carried out for the purpose of revising specifications have been concluded, and the specifications revised to require an 8-inch projectile much superior to that produced under the former specifications.

New range tables were calculated for 8-inch 2,700 f. s. and 14-inch 2,600 f. s. firing. This completes the range tables based on actual ranging for the major caliber guns of the fleet, except for the 12-inch guns on the *Florida* and *Utah*.

THE naval powder factory at Indianhead, Md., has operated continuously throughout the year at a daily output of about 10,000 pounds, which gave a total output of 3,031,312 pounds of new and reworked powder. In addition to this powder, a small quantity was purchased from commercial manufacturers at a price somewhat less than the total cost of manufacture at the naval powder factory. While the naval powder factory has a capacity capable of producing more powder than is needed by the fleet in time of peace, it is essential that commercial sources of supply be available to meet war-time demands.

All small arms ammunition for service weapons obtained during the year was purchased from the Army in accordance with the practice of many years' standing. A small amount of special and training types of small-arms ammunition was purchased from commercial cartridge companies.

Aircraft gunnery exercises and the increasing employment of machine guns for defense against aerial attack causes a constantly increasing demand from the fleet for small-arms ammunition. The program of reworking, reblending, and reassigning old powders has been continued and has resulted in a considerable saving.

Funds available for the purchase and manufacture of new powder have been insufficient to meet the annual expenditures for target practice and test firing requirements. An existing shortage in the amount of powder required by departmental instructions is increasing because of the withdrawal of old and deteriorated powders from service use. Much of the powder on hand obtained prior to and during the World War is reaching the end of its stable life and must within the next few years be withdrawn from service.

On July 27, 1928, a magazine building at the naval ammunition depot, St. Juliens Creek, Va., containing 643,611 pounds of smokeless powder, took fire from an undetermined cause, probably deterioration of powder, and was completely destroyed. There was no injury to personnel or to any other material than the one building and its contents.

Assembled ammunition on hand, particularly that remaining from the war, is being broken down and overhauled as rapidly as time and funds permit. The procurement of ammunition details has been satisfactory except for aircraft flares. Research and development work on these flares is progressing.

The restowage of ammunition and explosives at ammunition depots and the provisions of additional storage facilities to comply with the safety standards of House Document No. 199, Seventieth Congress, is being prosecuted vigorously. Remodeling of projectile storage buildings at several depots is under way. Contracts for the construction of a new high explosive storage depot at Hawthorne, Nev., have been let and work is under way. It is expected that magazines at Hawthorne will be available for the storage of explosives by the fall of 1930. Plans for a relocation of the depots in the Hawaiian and Philippine Islands are being prepared, and steps toward the procurement of necessary property are being prosecuted. Additional barrier properties for the depots at St. Juliens Creek, Va., Puget Sound, Wash., and Keyport, Wash., have been obtained, except that in a few instances final transfer of titles has not been completed.

Plans have been made and funds are available for the construction of six new magazine buildings at Lake Denmark, N. J., which should be completed by January, 1930, and plans are in process of development for increased safe storage of explosives at Mare Island, Calif. Upon the completion of high-explosive storage facilities at Hawthorne, Nev., and the magazines for smokeless powder at Lake Denmark, N. J., the existing congestion of ammunition storage will be rapidly relieved.

Restowage of explosives at Yorktown has been continued. All explosives have been removed from the old aviation field. The work of removing bulk TNT from underground caches and reboxing same for storage in magazines preparatory to shipment to Hawthorne, Nev., has been started.

The U. S. S. *Nitro* has been the principal means of transportation of ammunition between the depots on each coast. Her capacity at maximum operating speed is barely sufficient to supply the west coast depots and the Battle Fleet in the Pacific Ocean with target-practice ammunition. An additional ammunition ship is needed.

MODERNIZED fire-control systems for the *Oklahoma* and *Nevada* have been completed and are being installed. The main battery and antiaircraft fire-control systems of the *Salt Lake City* and *Pensacola* have been installed and await test. A modern antiaircraft fire-control system for the *Tennessee* has been installed and tested suc-

cessfully; that for the *California* has been completed and is in process of installation.

Contracts have been placed for modernized fire-control systems for the *Pennsylvania* and *Arizona* and for cruisers *Nos. 29* to *31*, inclusive. A contract has been let for torpedo-control systems for 24 destroyers. This, when completed, will provide every destroyer in commission with a follow-the-pointer system.

With the purpose of reducing the cost of bombing practices, three new types of practice bombs have been developed which have excellent flight characteristics. A new type of gun camera that is adaptable for use as either a fixed or a free gun camera is being built by the Naval Research Laboratory with every promise of success. A new type of antiaircraft target sleeve has been adapted from the Army target. It is found to tow more steadily and with less drag than previous types. A new aerial target reel has been manufactured during the year and tested with satisfactory results. This reel is designed for use with antiaircraft targets with the purpose of reducing the time lost by surface vessels during target practices and conserving towing wire and targets.

The development of bomb sights and the determination of flight characteristics of bombs has been continuous throughout the year. The replacement of wooden bomb crates on ships with metal crates with the purpose of reducing fire risk and saving weight has progressed satisfactorily during the year.

THE design section of the bureau has been so fully occupied with work on the modernization of battleships and on new construction that progress on novel developments in ordnance is seriously in arrears. There is urgent need for an increase in the design force of five assistant and junior engineers to make possible an orderly and necessary progress toward the solution of many problems in ordnance design that are now before the bureau. Among these design problems of major importance are a large caliber machine gun for use against aircraft and secondary and antiaircraft guns for replacement battleships.

General arrangement and detail drawings for modernization of the *Pennsylvania* and *Arizona* have been completed and copies furnished the Philadelphia and Norfolk Navy Yards. Similar drawings have been started for modernization of the turrets of the *Mississippi* class.

The design and a preliminary working model have been completed of a new type torpedo director for use on submarines. A new type combined torpedo and bomb rack for use on the wings of an airplane has been designed, manufacturing drawings prepared, and a project order issued for its manufacture. A new type of powder packing box to be used in transporting powder from the powder factory to the ammunition depots has been designed and the samples manufactured and tested. Welded seams have been substituted for the rolled and soldered seams, and tests indicate that considerable saving in cost of repairs will result from the use of this new type packing box. A contract has been made for the manufacture of 25,000 packing boxes of this type.

General arrangement and detail drawings have been prepared of a lightweight antiaircraft machine gun mount for use in the tops of light cruisers and battleships. A new type roller bearing has been designed, tested, and found satisfactory for the 8-inch triple mounts on light cruisers.

RESEARCH and experimental work for the bureau has been performed at the Naval Gun Factory, the Naval Proving Ground, the Naval Powder Factory, the Naval Torpedo Station, Newport, R. I., the Naval Ordnance Plant, Baldwin, Long Island, the Naval Research Laboratory, the Naval Aircraft Factory, and the Bureau of Standards.

Valuable assistance has been obtained from the Chemical Warfare Service of the Army and by the coöperation of some commercial manufacturers of powder and metal products.

Problems investigated by research methods during the year have included metal alloys for use in the manufacture of ordnance material, changes in gun and projectile design to reduce dispersion, improvement in pyrotechnics, equipment for making smoke screens, fuzes for projectiles and bombs, torpedoes, flares, tracers, and optical instruments.

THE naval torpedo station, Newport, is engaged in the manufacture of all torpedoes for new vessels and of all replacement torpedoes and has continued the modernization and conversion of torpedoes in accordance with the program authorized by the bureau. It has also manufactured material to be used by the Pacific coast torpedo station in the conversion and modernization of torpedoes.

The stock of torpedo and air-compressor spare parts and tools and similar replacement material has been placed on a more satisfactory basis as to quantity available to meet requirements of the service. During the last half of the year the torpedo station has been engaged in a revision of all torpedo, air-compressor, and work-shop equipment allowance lists in accordance with instructions issued by the bureau. It is expected that the revised lists when completed will be more uniform and accurate than lists heretofore in use. Continued successful efforts have been made to improve the quality of workmanship and to decrease cost of production. A study of shop methods, progress of work through shops, regrouping of machinery, inspection methods, and procurement of more modern machine tools and appliances has resulted in a progressive increase in output at decreased cost. This study points to the economy of procuring the best and latest types of machine tools whenever replacements become necessary and funds therefor are available.

THE Naval Gun Factory has continued during the fiscal year 1929 in its upward trend of increased personnel and production of ordnance material for new construction and for modernized vessels. The working force has been increased about 12 per cent over that of the preceding year, bringing the total shop employees to 4,300. The office and drafting forces have been increased only 3 per cent. The shop force is considered to be well balanced and is satisfactorily taking care of the work in hand.

A schedule of production covering future demands for delivery of material has been made out, and it appears that the gun factory will be able to meet the date of completion set by the Navy Department for modernized vessels and, with the assistance of the Army arsenal at Watervliet and the award of twelve 8-inch guns to commercial industry,

will provide guns and mounts in time to meet the completion dates of cruisers *Nos. 32* to *36*. Economy and expedition of production can be improved by the provision of new and more modern machine tools. This has been made the subject of separate recommendation.

Through improved melt practices, allowing utilization of scrap metal in lieu of virgin metal, it has been possible during the year to effect very material savings in foundry work. Two labor-saving devices acquired by the steel foundry, a flask rapper for knocking out large castings from flasks, and a sand separator and blender resulted in a saving of about $4,000 for labor. The volume and scope of work undertaken and accomplished by the inspection, metallurgical, and testing divisions is considered very satisfactory. Valuable progress has been made in research and experiment looking toward the further utilization of rust-proof metals, new alloys of steel, aluminum, and chrome plating for ordnance purposes.

The administration of the Naval Powder Factory and of the civilian community living on the reservation has been satisfactory for the year. During the year the naval powder factory manufactured 2,758,992 pounds of smokeless powder and reworked 272,320 pounds. The total amount of powder expended by the Navy during the year, including losses through deterioration of old powder, was 4,118,703 pounds.

Powder in storage in the factory has been thoroughly overhauled and restored. All powder for sale has been disposed of and conditions of powder storage are better than for several years. Many old and obsolete structures have been dismantled and removed to prevent fire hazard. Wood floors in two large magazines, on exposed platforms of blending tower, in the press house, and in the solvent recovery area have been replaced by permanent concrete with an eventual large saving in unkeep and repair. Facilities for storage in the magazines on the station are only just sufficient for the present manufacturing program.

The naval proving ground fired a total of 5,055 rounds of all calibers from caliber .30 machine guns to 16-inch 45-caliber guns. The total amount of powder expended was 245,628 pounds. This was a decrease of 3,275 rounds fired and an increase of 26,539 pounds of powder expended in the fiscal year 1928.

An extensive series of experimental firings was during the year conducted with the purpose of reducing the dispersion of certain major-caliber guns in the fleet and to find a means of increasing the life of guns by reducing erosion. It is believed that reports of target firing in the fleet show that dispersion of the major-caliber guns is in process of correction, and results of the erosion tests promise a longer life for the guns.

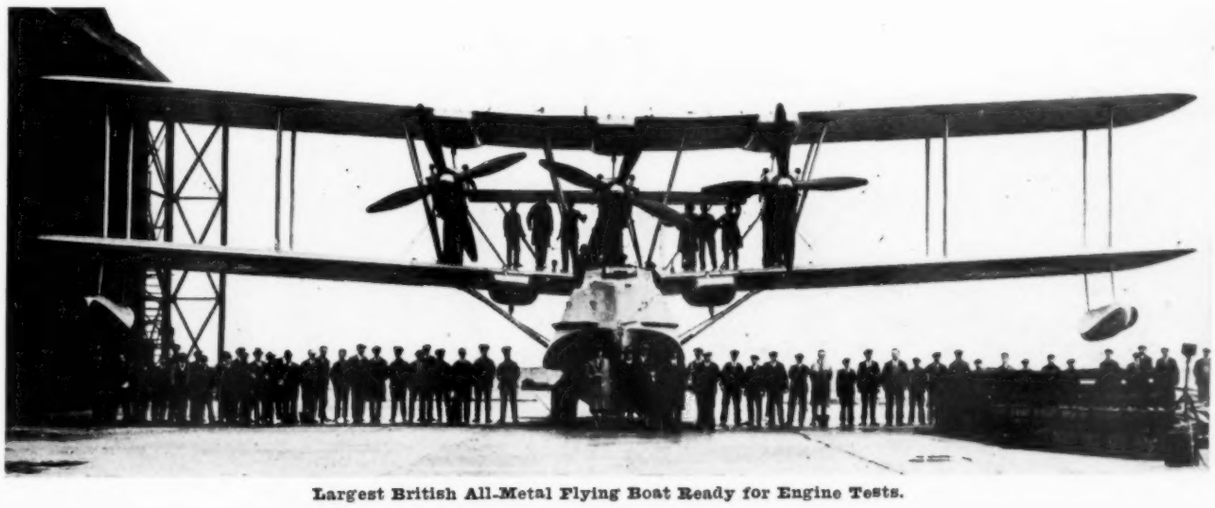
A continuous increase in demand for illuminating projectiles by the fleet, both surface vessels and aircraft, has up to the present time been met by the output of the naval ordnance plant at Baldwin, Long Island.

This plant because of its location in the town of Baldwin, Long Island, is incapable of expansion, and the continuously increasing demand for pyrotechnics will in the near future necessitate its removal to some other locality where there is room to expand.

During the year 77 new magazine buildings designed for the storage of high explosives at Navy Mine Depot, Yorktown, Va., were completed and all explosives that previously had been kept in open storage were moved to the new magazines or to underground caches. An underground telephone system to be used in reporting fires was completed during the year, giving safe telephone connection to each of the old magazines and to each group of the new magazine buildings. The provision of a modern system of lightning protection was started and will be completed in the next fiscal year. The preparation of bulk explosives for shipment to Hawthorne, Nev., was commenced in June, 1929, and will be continued during the next fiscal year as personnel is available.

The work at the Naval Ammunition Depot, Lake Denmark, N. J., has been directed toward repairs to the material damaged in the explosion that occured in July, 1926. Large quantities of damaged fuzes and primers were collected and destroyed in a burning pit constructed for the purpose, and about 1,900 tons of damaged projectiles and structural material were disposed of by sale. Repairs to some of the buildings and installation of primary lightning protection on these buildings were accomplished by the station force. The completion early in 1930 of six magazine buildings for which funds are available will permit of again using this depot as a storage for smokeless powder and projectiles.

WILLIAM D. LEAHY,
Chief of Bureau.



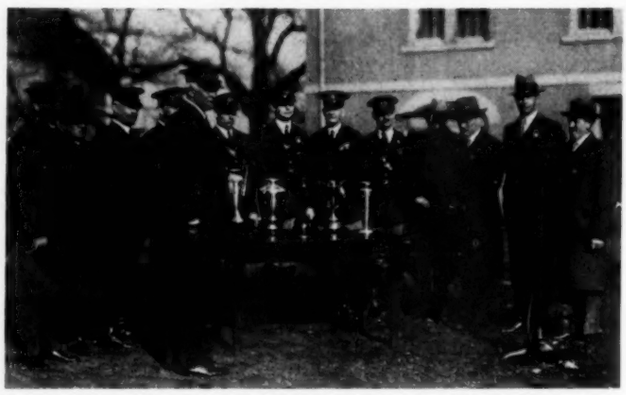
Largest British All-Metal Flying Boat Ready for Engine Tests.

They Can Make Guns and Use Them

New York Ordnance Reservists are Pistol and Rifle Shots

By Chas. H. Keck*

DURING the past three years small - arms competitions have become one of the outstanding activities of the Ordnance Reserve Officers in the Second Corps Area. In 1928 the ordnance team captured all of the corps area trophies for pistol marksmanship, and in addition the Army Ordnance Trophy for the best ordnance team in the United States. This year they repeated the performance retaining all of the trophies won in 1928, and in addition a team of reserve officers composed essentially of ordnance officers took the Luquer Cup which is competed for each year by the Regular Army, National Guard and Organized Reserves in the Second Corps Area.



Gen. H. E. Ely at Governors Island, N. Y., Awarding Trophies and Medals to Winners of Second Corps Area Championship Marksman Contests.

Left to Right: Maj. J. H. Hessian, Ord. Res.; Capt. C. L. LeVien, Ord. Res.; Capt. C. H. Bobb, Ord. Res.; Lieut. W. A. Menger, Ord. Res.; Capt. T. R. Mullen, Ord. Res.; General Ely; Lieut. J. E. J. Clare, Jr.; Maj. E. J. Dougherty; Lieut. L. DeLeman; Lieut. H. A. Harris, Ord. Res.; Col. Swartzkopf; Lieut. W. Amundson; Capt. L. J. Corsa, Ord. Res.

The Ordnance Rifle Team likewise captured the McNary Trophy, both seasons. This trophy is awarded for excellence in small bore work.

The pistol team was organized in December 1927, and consists of five officers and two substitutes who were selected from a general tryout of all ordnance reserve officers interested in shooting. Facilities were obtained for weekly practice in the 102nd Engineer Armory, New York City, where we had the use of three firing points. This indoor practice was supplemented during the spring by outdoor firing at the Camp Fire Club at Braireliff, N. Y. Through the good offices of Maj. John W. Hession, Ord. Res., we were given the privilege of this club for outdoor practice, and had many interesting Sunday outings there. The team made progress from the start, but at this time there was only one trophy in the corps area to complete for, namely the Bell Trophy, given for the best organization team in the Second Corps Area. In this competition the ordnance team won second place in 1927, leaving the trophy to the 308th Infantry. However as this was an organization trophy, it was necessary to remove several of the best shots from the team in order to make it an organization team.

TO increase the interest and develop competitions in which all reserve teams would be eligible, it was necessary to get more trophies. The situation was placed before the officers and two cups were presented to the Commanding General in 1928, to be awarded annually, one by Col. Cyrus Field Judson, Ord. Res., known as the Leonard Wood Trophy for the best branch pistol team, and the other, known as the McNary Trophy, was presented by Col. James E. McNary, Ord. Res., to be awarded to the best small bore team in the Second Corps Area. The New York Post, Army Ordnance Association, also presented two cups to be awarded to the best ordnance teams in the United States for excellence in pistol marksmanship. In addition to the above mentioned trophies there already existed in the Corps Area, the Bell Trophy to be awarded each year for the best unit team, and the Luquer Trophy to be competed for each year by one team from the Regular Army, National Guard, and Organized Reserves, taken at large.

The Ordnance pistol team for 1929 consisted of the following officers: Lieut. Col. Calvin H. Goddard, Ord. Res.; Maj. John W. Hession, Ord. Res.; Cap. Christopher L. Le Vien, Ord. Res.; Capt. Clarence H. Bobb, Ord. Res.; Capt. Thomas R. Mullen, Ord. Res.; Capt. Lawrence J. Corsa, Ord. Res.; 2nd Lieut. Walter A. Menger, Ord. Res.

The various Corps Area small bore trophies were presented to the contestants by Maj. Gen. Hanson Ely, at Governors Island, New York, on October 28, 1929. Of the trophies awarded the above team was presented the following: Leonard Wood Trophy, best branch pistol team; Bell Trophy, best unit pistol team; Army Ordnance Trophy, best ordnance team in the United States.

In addition four members of the above team, namely, Colonel Goddard, Major Hession, Captain Corsa, and Lieutenant Menger, were members of the Composite Corps Area Reserve Team which won the Luquer Cup from the Regular Army and National Guard. The above trophies were the result of elimination contests. In the Bell Competition sixteen teams were entered in 1929.

The Ordnance Rifle Team was composed of officers who were also members of the pistol team. The personnel of the team was as follows: Maj. Hession, Captain Corsa, Captain Mullen, Captain Le Vien and Captain Bobb.

This competition consisted of twenty shots prone at 100 yards, using the standard American target, iron sights, and any caliber .22 rifle. The team average in the match fired in 1929 was 96.10 per cent. Captain Corsa made the outstanding score in match rifle firing registering a possible or twenty consecutive shots in the bull.

*Asst. Ordnance Officer, Second Corps Area, Governors Island, N. Y. Treasurer, New York Post, Army Ordnance Association. Captain, Ordnance Department, U. S. Army.

Control of Strategic Raw Materials

A Plan for the Abatement of War by Industrial Agreement

By Edward N. Hurley

THE following is a letter, dated November 20, 1929, addressed by Mr. Hurley to M. Georges Theunis, President, International Chamber of Commerce, Brussels, Belgium, in which the author offers a plan for the abatement of war through the control and allotment of strategic industrial raw materials in such a manner that they will not be available for war-making purposes. It is proposed that an understanding to this effect be instituted among the leaders of the key industries of the world and that it have the sanction of a gentleman's agreement only.

Mr. Hurley, a manufacturer and engineer of international repute, during the World War was a member of the War Council, American Red Cross, and was chairman of the U. S. Shipping Board and president of the Emergency Fleet Corporation, July 1917-July, 1919. He originated and developed the pneumatic tool industry in this country and Europe. In 1913 he was appointed U. S. Trade Commissioner to Latin American Republics and later became chairman of the Federal Trade Commission. He has served with distinction in many manufacturing and financial enterprises and has an outstanding record of public service.

His thesis, which follows, is unique in that it proposes the abatement of war through means which virtually prescind from any governmental agency. By agreement between individuals controlling industrial commodities essential to the prosecution of war, he would proscribe the use of those materials to any nation and thus prevent the manufacture of instruments of war. Although this idealistic theory, in our opinion, contains many points which are impracticable, we present Mr. Hurley's text to members of the Army Ordnance Association as a matter of interest in a cause so closely associated with our own—an industrial method for the prevention of war.—Editor.

M. GEORGES THEUNIS, President,
International Chamber of Commerce,
3, Montagne du Parc,
Brussels, Belgium.

My dear Mr. President:

The International Chamber of Commerce is the only body organized to ascertain and give expression to the community of thought and opinion which exists among the business men and industrial executives of the world.

It is, therefore, in a position of unique responsibility and opportunity with respect to the world-wide effort to abolish warfare among the nations. It can bring decisive influences to the aid of the many groups throughout the world who are seeking to establish permanent peace as the foundation of a new world order.

The constitution of the International Chamber provides that it shall represent all the factors of international business, including finance, industry, transportation and commerce; that it shall ascertain and express the considered judgment of those interested in international business and by encouraging intercourse and better understanding among business men and business organizations of the various countries shall promote peace and cordial relations between nations.

I deem it appropriate, therefore, to bring to your attention a practical plan for the permanent abatement of warfare among nations through the control of the raw materials without which modern wars cannot be carried on. I offer this plan in bare outline as a suggestion, with the thought and hope that you will see fit to submit it for consideration and elaboration to the proper staff officials and committees of the International Chamber, in order that it may crystallize into a more definite and detailed proposal to be discussed by the business men of the world.

After the proposal has been thus clarified and amended by criticism, it is my hope that it be placed upon the agenda of the next international meeting of the Chamber.

If it should be there indorsed and embodied in appropriate resolutions, methods for the practical realization of the hopes which have inspired the proposed plan undoubtedly will be considered by the industrial leaders who control the industrial raw materials of the world, and with the prestige of the Chamber's indorsement, it is not extravagant to expect a speedy fruition of agreements among them which will lead to the control and allotment of strategic industrial raw materials in such a manner that they will not be available for war-making purposes.

IT goes without saying that the industrial leaders who head the key industries of the world are in agreement with the International Chamber in its pacific objectives. Their entire lives are devoted to the production of wealth in order that the estate of mankind may be improved through peaceful accumulation.

Modern war, which has itself become a gigantic, if destructive, industrial enterprise, is to them a ruthless competitor for the materials which they normally employ in the industries of peace. Current proposals for the maintenance of world peace have laid little or no emphasis upon industrial methods for the prevention of war.

However, the most practical method of perpetuating world peace and world prosperity is the inauguration of a control of industrial materials for war by the leaders of world business.

The "will to peace" is now so manifest, so widespread and is shared to such an extent by the peoples of the most powerful States, that we no longer discuss the issue of

"peace *versus* war" to any extent; but devote our thoughts to the method by which this peace objective may be attained. That, in itself, is a most striking proof that nations have made a substantial advance from conditions under which the great majority of mankind regarded war as a natural phenomenon as inevitable as wind and wave. It is not my idea to suggest an all-sufficient and exclusive method of promoting international tranquility. The causes of war are many and complex; and it is altogether unlikely that any simple remedy will be found for avoiding it. I think therefore, that the suggestion and promotion of any means of preventing or limiting the scope of warfare is valuable at this time, because there will be a use for *every* kind of preventive agency that humanitarianism and diplomacy can devise.

FAST progress has been made since 1918 in the forging of moral restraints on war. Equally remarkable progress has been made in the realm of political prevention. No other period has offered such tangible monuments of international statesmanship as the League Covenant and its embodiment in a "going," international concern in which most of the States of the earth are active participants and with which the others sustain factual relations. The World Court, the Kellogg Pact, the actual limitation of armament which resulted from the Washington Conference, and the achievements of Presidents Coolidge and Hoover coöperating with British and Continental statesmen for further limitations have placed peace-making within the scope of practical world politics. The manner in which the financial problems left in the wake of the World War have been used to promote a better understanding and coöperation among the leaders of world banking and trade is a gratifying proof that good may continue to come from evil.

Such evils as indemnities and reparations are necessary, in present circumstances; but, under the leadership of Gen. Charles G. Dawes, Mr. Owen D. Young and a host of European statesmen or financiers who have coöperated with them, long steps have been taken towards an international organization of finance which is bound to promote world trade and enhance the welfare of peoples.

It has been proposed to create devices for international control over credit by denying to warlike aggressor nations any access to the banking resources of the world. I have no doubt that the proposal eventually will be embodied in a workable arrangement. But it is easy to discern breaches in the fortifications which already have been erected for the protection of international order.

Battlements of moral purpose often have been washed away by floods of passion easily drawn from the wells of primitive instinct by chauvinistic demagogues. Political machinery is notoriously subject to the same kind of mishaps. That the bonds of financial interest and ties of trade are feeble fetters for the war spirit the world knows only too well. The volume of international trade in 1913 had reached a point which it has regained only recently.

That wars cannot be fought without money is a sophistry which withers under close scrutiny. While it is obvious that any belligerent today would be seriously handicapped if denied access to the money markets of the world, we should not forget that the Central Powers in the recent conflict had arrayed against them the greater part of the world's banking power; but despite that fact they never lacked the means to obtain in foreign markets anything they could slip through the blockade. Wars fought on fiat money have been many. The first French Republic fought the rest of Europe "to a draw," on worthless *assignats*. Our own Continental currency, which largely financed the American Revolution, is still "not worth a Continental"—an American folk phrase denoting utter lack of value; and the enormous quantity of Confederate bills still in existence sixty-five years after the close of the American Civil War is a convincing reminder of the independence of military effort and sound finance.

THE nations will not be wise if they trust too much in mere disarmament. A cynic might even suggest that "the worse men are armed, the better they fight." It certainly is true that, in proportion with the number of men engaged, the wars preceding the invention of gunpowder were far more bloody than those which have followed them. Modern industrial nations adequately equipped with chemical, metallurgical and electrical enterprises are armed at all times with weapons of frightful power, provided they can be assured all the raw materials which those industries require. At the same time, such nations are exceedingly vulnerable to attack, on their great cities and their concentrated populace dependent upon complex and delicate systems of transportation, water supply and power transmission.

It seems to me that in the present state of technology and commerce, no peace-preserving machinery can be complete without some form of international control of raw materials. I can conceive of a great nation defying the moral opinion of the rest of the world, laughing to scorn the political machinery set up to prevent war and snapping its fingers at the masters of the world's credit; but I cannot conceive that any nation could indefinitely continue to resist the world if it were deprived of any three or four of the important raw materials which enter largely into the world's commerce. The real weak spot in the armor of Mars lies just there.

There is no modern industrial State which in all respects is self-sustaining. If the important war-making materials of the world were under some form of international control so that those materials could not be hoarded in great quantities as a preparation for war, no nation could sustain modern war beyond a very brief period. This was well known to the German rulers prior to the outbreak of hostilities in 1914; and we now know that had it not been for the perfection of the Haber process for the fixation of atmospheric nitrogen, the Central Powers would have been crushed within a few months. A complete survey of the possibilities of preventing war by the control of trade in the raw-materials industries will not be attempted in this letter. It would be a work of encyclopedic proportions.

Fortunately, the task of preventing war by control of raw materials need not wait upon further research or statistical surveys. There is not even need to defer to the tricks and prejudices of domestic polities or the red tape and etiquette of conventional diplomacy. All that is necessary is for the great industrialists of the world to act upon information they already possess, as to the essential community of interest among the great business organizations

of the world. The business leaders of the world today are in fact an international, "economic republic" similar to that international "republic of letters" which was discerned by the philosophers of the eighteenth century. There exists among them an identity of motive and of mental habit similar to that which obtains among the men of science in all nations. In addition to this essential similarity of mentality and motive, they possess through their control of crude raw resources, transportation agencies and factory plant, vast powers of control which could be exerted against any government which set out to disrupt the machinery of world production and distribution. The great industrialists of the world have devoted their energies toward the maintenance and enhancement of human productivity. That alone should be sufficient inspiration for them to use their utmost powers against any reactionary military or political clique that attempted to interfere with their work by reviving the inhumane and destructive passion for military conflict.

I WILL not undertake to argue whether "land hunger" ever was either a moral or economic *justification* of war; but it may be admitted that land hunger was an incentive that did *cause* a great many wars. It may be admitted also that as long as most of the wealth of the world was in the form of land, war could be made to pay. By annexing territory, the victor substantially increased his wealth. Modern industry has created new categories of wealth and income to such an extent that agricultural land is but a minor fraction of the world's wealth; and in a modern war the victor who annexes land after damaging his trade and impoverishing his customers finds that he has impoverished himself perhaps even more than his vanquished foe. Business men understand this. They should act upon it. They have a further reason to use their utmost powers to banish war from the world. The modern capitalist, who has helped to create the new economic conditions which have made war unprofitable, is invariably branded as a war profiteer, when war breaks out. "Capitalistic greed" is popularly ascribed as the cause of wars—which in the long run diminish wealth. The error arises because the expense of war for a time creates the illusion of vast war profits. This is bound to be the case because the outbreak of any war immediately creates a "scarcity value" for all commodities and for the use of capital equipment. The possessors thereof immediately begin to receive enhanced "paper prices" for goods and services, while at the same time their prior investments are being destroyed by the direct or indirect inflation of the currency.

The politicians who precipitate war for party-saving motives are able to direct the anger of the multitude against the so-called profiteers. It seems to me that the business leaders of the world would tire of this role of scape-goat for the demagogue. If they ever do, they can take effective steps to make war a very difficult if not impossible enterprise. Any modern nation could be paralyzed by the refusal of business organizations in the other countries to sell to it ten or twelve essential raw materials such as iron ore, rubber, manganese, nickel, aluminum, news-print pulp, copper, oils, tungsten, chromium and mercury. The economic map of the world will disclose that no large State today could long produce, or reclaim from scrappings, sufficient quantities of these materials to sustain its industrial life. Although this has been called "the age of coal," "the age of steel," etc., it is in fact an age in which the machinery which is essential to production must be fabricated of materials drawn from all quarters of the earth. In such a commonplace instrument as a telephone or in an electric motor, are assembled materials in the bringing together of which distances of from five thousand to twelve thousand miles must have been negotiated; and the total mileage represented in such assemblings will run twice and thrice that measure. If the leaders of the great industries which own, control, transport, refine and fabricate the "key commodities" would not sell them to any actual or prospective belligerent, politicians would hesitate before precipitating wars. Ample precedent for such an industrial restriction already exists in the great cartels which already fix the world price on one or more of these essential materials without which war cannot be waged.

IF the industrial leaders of the world set about frankly and openly to form such a control, world applause would greet the effort. I am personally acquainted with many of the industrial leaders who could form such an organization. I am satisfied that they would adjudge this plan to be practicable, if it were presented properly for their attention and study; and I am certain that the motives of those men are such that naturally they are inclined to devote their powers to the common good of mankind. The only real obstacle to the association of such men in a project of this kind is their reluctance to enter domestic political controversies.

There are two or three dozen men in the world today who could meet and form a gentlemen's agreement to control the essential raw materials of the world in the interest of business stability and peace, and there is no force in the world today which could effectively forbid their exercising that control. There might be shrieks and protests from reactionary groups in all nations; but there is no political or juridical machinery anywhere which could be effectively invoked to prevent such an humanitarian undertaking. The thing could be done without political influence, in republic or monarchy. No approval from any government is needed. Official disapproval would be a gesture that would be rebuked and would go unheeded while popular sentiment everywhere was crystallizing in support of such a supreme act of common sense.

To make this phase of the proposal specific, I will mention the names of several men who, by virtue of corporate positions and their tremendous moral influence upon the rank and file of their respective industries control the disposal of the raw materials without which war cannot be waged. Walter S. Teagle, President of the Standard Oil Company of New Jersey, and Sir Henri Deterding, Managing Director of the Royal Dutch Schell Corporation of Great Britain, can say whether automobiles and airplanes shall continue to move and whether the machinery of the world shall continue to produce goods or be stopped by friction. John D. Ryan, Chairman of the Anaconda Copper Mining Company of New York, and Monsieur E. Franque of Belgium, are in a position to control the distribution of that copper without an ample supply of which the electric energy of any country cannot be generated or

distributed effectively. Harvey Firestone of the United States, and H. Eric Miller, Managing Director of Harrison's & Crossfield (British) command such confidence among the men who produce and manufacture rubber that they can mobilize that industry in the cause of war prevention. The modern world is energized over copper wires and is moving more and more on rubber. Yet it is a world in which energy must still be generated from coal; and the energy must be harnessed by machines made of steel. Coal and iron are far more widely distributed than copper, oil and rubber. The allotment of steel to the nations of the world could be determined very largely by concert of such men as these: For the United States—James A. Farrell, President of the U. S. Steel Corporation; Charles M. Schwab, Chairman of the Bethlehem Steel Corporation; Willis L. King, Vice President of the Jones & Laughlin Steel Corporation; James A. Campbell, President of the Youngstown Sheet & Tube Company; for Great Britain—Sir Hugh Bell, Rounton Grange and Sir Arthur J. Dorman, of Dorman, Long & Co.; Sir Robert A. Hadfield, Chairman of Hadfields, Ltd.; for Germany—Dr. Albert Volger, General-direktor of Verein Deutscher Eisenhutten Leute; Dr. Fritz Thyssen of the Stahlwerks Verband; for Belgium—Jacques van Hoegarden, Managing Dir., Societe Anonyme D'Ougree-Marihaye; for France—Eugene Schneider of Schneider & Co.; Francois de Wendel, Manager of de Wendel et Cie; Alexander Dreux, President of the Societe des Acieries de Longwy.

The technical genius of Italian engineers and industrialists is such that business leaders of Italy would have an important part in the control of steel and all ferrous materials despite the fact that Italy is not richly endowed with the raw materials of these industries. Her importance as a consumer and fabricator would make it necessary for such men as Sig. Alberto Pirelli (former President of the International Chamber of Commerce) and Count Giuseppe Volpi (former Minister of Finance) to lend their influence in any plan for coördinating the metallurgical industries. Coal is not subject to such closely correlated personal influence, yet it would not be difficult to find five or six men who could command the support of the great majority of the producers in their respective countries if a program so eminently sound and beneficial enlisted their whole-hearted support. As custodians of the fossilized energy upon which modern civilization depends, the coal producers of the world owe a high degree of responsibility to mankind. Before their industry came into the world the limitations of civilization were indeed narrow, because all that man might achieve mechanically was limited to the working capacity of human and animal muscle. If we care for ultimate analysis, it is not too much to say that modern industrial civilization came out of the coal pits. It is just as true to assert that modern warfare is necessarily rooted in coal mines.

THANKS to the magic of modern chemistry, the possession of a very few raw materials enables a modern State to make almost any desired finished product or a useful substitute for it. The chemical industries of the world could be mobilized for world peace by business control if a few men like Pierre S. Dupont of the United States, Dr. Carl Bosch and Dr. August Diehn of Germany, Lord Melchett and Sir William Alexander Barta of Great Britain and M. Donat-Agache of France "got together" and determined to do it. The strategic position of the chemical industries with respect to war-making and peace-maintenance is somewhat similar to that of the gigantic enterprises which provide the world's workshops with electrical energy. The organization of the electrical manufacturing and utility enterprises of the world is such that the outstanding leaders can exercise a very marked influence upon its activities everywhere. The great research laboratories of the major electrical and automotive industries produce knowledge and processes which are continuously improving technology. Any nation deprived of free access to the methods and machinery which are the fruits of their research would be absolutely handicapped. Such men as Owen D. Young, Chairman of the Board of the General Electric Company (already one of the most conspicuous leaders in the movement for world order and security), Gerard Swope, President of General Electric, Charles F. Kettering, Vice President, General Motors Research Corporation, and A. W. Robinson, Chairman of the Board of the Westinghouse Electric Co., could bring about not only sentiment but constructive action towards mobilization of electrical enterprise for the abatement of war.

There are other materials without which modern warfare cannot be waged. The volume of them is altogether out of proportion with the paralyzing effect that their withholding would produce. As all steel men in the United States know, at one critical period in the World War the United States had only a three-week's supply of manganese ore. If the four ships carrying supplies of this ore from Brazil had been delayed by German submarine activity, every steel plant in America would have had to shut down. Manufacture of high-speed steels, and our electric illumination are dependent upon an annual supply of only a few thousand tons of tungsten.

The commissary of modern armies is dependent upon ample supplies of tin, and not a rifle or machine gun in the world could be fired without mercury. The supplies of these raw materials are very largely absorbed and to some extent are controlled by the great metallurgical industries, which are in a position to exercise a very potent check on their distribution. The heads of these great institutions undoubtedly could provide against their distribution to belligerents. Most of the industrial countries can provide some of these materials from low grade ores, but at enormous expense; and the opening of such mines and setting-up of plants for the benefication of such ores would be a difficult task—difficult enough to delay the opening of hostitlties by any nation cut off from the usual world supplies.

The ending of the World War was brought to pass by slow starvation of the industries of the Central Powers and the consequent discontent and rebellious attitude of their civil populations. The German army never was defeated in the field, and under the conditions of former ages it would have required many years to have forced a surrender. Does the end of the last war point out to us the best method for preventing the beginning of another war? World business cannot starve Mars unless the leaders of world business acquire an unanimous or over-powering "will to peace," and not until they organize on common-sense business lines to get what they want.

Very sincerely yours,

Edward N. Hurley.

Snow Has No Peril for Men in Arms

U. S. Infantry With Skis and Snow-shoes on the March.

Members of the 3rd Infantry, stationed at Fort Snelling, Minnesota, making their way with snow-shoes and skis ready for down hill. American Army equipment must include all paraphernalia for rigorous cold of winter as well as the intense heat of the tropics.

Above the Clouds in the Italian Alps.

A picturesque view of hardy Italian Alpine troops as they scale the high peak of Bernina, 15,000 feet above sea level, during recent maneuvers. Most of the dangerous mountain passage was high above the clouds. Bitter cold and storms encountered made the journey particularly arduous.

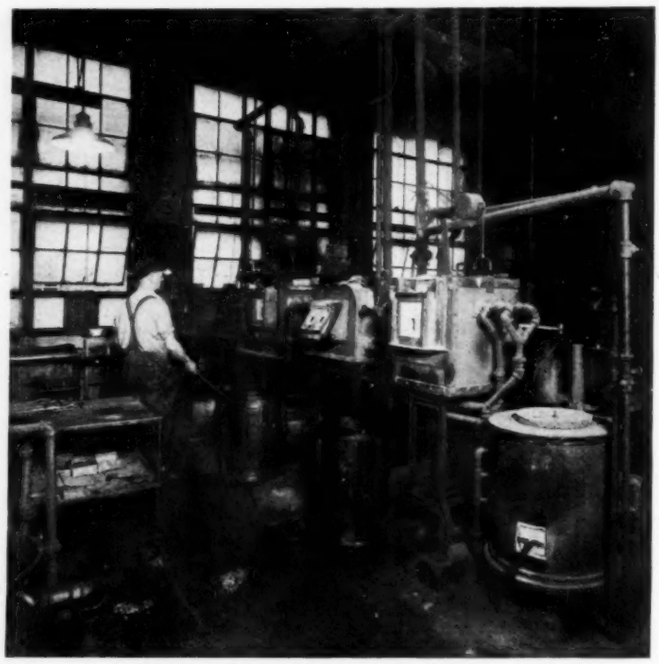
Manufacture of Machine Gun Parts

Machining and Heat Treating at the Colt's Plant

By J. B. Nealey*

IN time of war or periods of peace our great munitions plants afford us a sense of real security. While the bulk of the equipment, during peace time, is converted to the manufacture of a diversity of products unrelated to war, extensive experimentation and research must be carried on so that our arms and munitions will not become obsolete and ineffective in the light of new developments in other countries.

The basis for one of America's greatest firearms industries was whittled out of wood, on the high seas, in 1830 by Samuel Colt, who was then but 16 years of age. From this model was developed the famous arm with revolving cylinder, which fired six shots in succession, and the Patent Arms Company was organized by Colt six years later for its manufacture. This was eventually succeeded by the Colt's Patent Fire Arms Manufacturing Company with an extensive plant in Hartford, Conn.



Gas-fired Furnaces at the Colt's Plant.

More recently still the automatic pistol, which shoots more rapidly, came into the picture and today the Browning pistol, made by Colt's, is the world's foremost pistol. However, the revolver and pistol business of the company are about equal. The machine gun up to the time of the World War had not been accepted for general war use, although a Browning gun, also made by Colt's, had some use during the Spanish-American War. This machine gun together with an automatic rifle, were later perfected at the Colt plant by this same John M. Browning, the world's foremost gun wizard, and was tested and proven one month after America threw her lot with the Allies.

During the war there was manufactured in this plant 1,000 heavy Browning machine guns, 9,000 Browning automatic rifles, 1,000 heavy Vickers aircraft guns and 12,000 heavy Vickers machine guns. After the war Colt's was asked by the Government to work upon an automatic antiaircraft gun and an automatic tank gun. The result has been a 37-mm. automatic antiaircraft gun which discharges a one and a quarter pound projectile, eight miles into the air, at a rate of 120 per minute. It is the Browning masterpiece. A new tank gun has also been developed.

While the Colt automatic machine rifle arrived too late to be a factor in the late war, it will undoubtedly play a large part in future conflicts. Air-cooled and gas-operated, this rapid fire gun can be fired from the shoulder or hip, one shot at a time, like an ordinary rifle, or, by simply throwing a lever, converted instantly into the lightest "machine gun" now manufactured.

The weight of this gun is 16 pounds, its magazine will hold 20 cartridges and it can be fired at the rate of 500 shots per minute. Expanding powder gases furnish the energy for the operation of this gun. After it has been fired and the bullet passes the gas port in the barrel, the live powder gases expand through the port, into the gas cylinder and exert pressure against the head of a piston, which compresses a recoil spring for the return movement. The cartridges are forced up from the magazine by a spring and are fed into the barrel by the action of the piston or bolt return.

ALL parts of Colt's firearms are made from either bar stock or drop forgings from special steels, made at the steel mills to Colt specifications. Some idea of the multiplicity of machines used can be gained from the fact that in making the Colt revolver there are 691 operations while the automatic pistol requires 728. In addition, there are 183 and 187 inspections respectively.

The forging section of this plant consists of a long room with huge hammers and presses lined up on both sides, and it is here that many parts are blanked, forged and trimmed. The pistol frame is forged in one piece. While some gun manufacturers forge the barrels from billets, the practice here is to turn them from heat-treated stock on specially built lathes. An adjoining department is equipped with blanking presses of all sizes from the smallest up to those of mammoth proportions. Most of the work done here is cold, but stock for the largest parts is first heated to forging temperature, in a gas-fired forging furnace.

The barrel and cylinder department is equipped with long rows of power-driven automatic barrel lathes for turning the barrels and cylinder lathes on which are produced the revolver cylinders. The barrels are turned from round

*American Gas Association, New York, N. Y.

stock in four operations, that is, the surplus stock is removed and the barrel tapered in four successive cuts, and by four different cutting tools, after which they are ground. These tools travel along the length of the barrel at the rate of 1 8/10-in. per minute and at the same time the barrel revolves at the rate of 180 r.p.m. One lathe will turn out 6 barrels per hour.

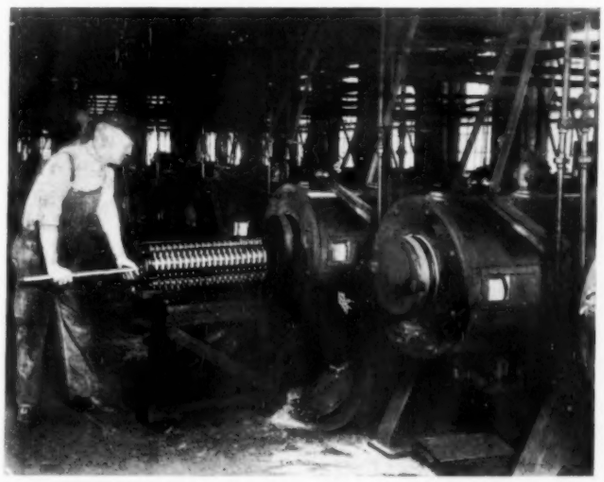
Machine Gun Barrel Reaming and Rifling Equipment.

The barrels are bored before they are turned down to shape and this boring is accomplished on a machine with a base like a lathe and on which is mounted two spindles at one end. Barrel blanks are placed in each spindle and revolved at the rate of 1,700 r.p.m. while drills, mounted on a carriage, bore into the stock at the rate of an inch a minute, the feed being accomplished by a long screw. This operation is held to a tolerance of 0.004-in., after which they are reamed in similar machines holding to a tolerance of around 0.001-in.

Batteries of rifling machines are used for rifling, the rifling consisting of four grooves. The barrel is held stationary in a chuck on a lathe bed, while a rotating rod with a cutter travels through, cutting one groove at a time. The rod revolves at the rate of one turn in 10 inches of travel to cut the grooves which are each 0.0035-in. deep. As soon as one groove is cut the chuck makes a quarter turn and another is started. These operations are all automatic and it requires 20 minutes to rifle a barrel. Different bores have different settings and the cut is controlled by a depth gage. Drill presses are used for boring revolver cylinders.

Large departments filled with automatic screw machines turn out most of the small parts that are not forged. Elsewhere are numerous milling machines, profiling machines etc., etc., some of which are unique. A good example is the slotting machine, for the side plate, which cuts two slots of unequal rate, the plate then being reversed and two more cuts made. To do this one cutter is held stationary while the other is on a swinging arm so that it can be quickly set for the reverse positions. By setting one cutter in advance of the other the difference in slot lengths is allowed for.

The reduction of a steel plate, except for an inch at the start, is accomplished in a machine with a traveling top on which the plate is fastened. The plate is moved along under a milling cutter which takes off a cut 5-ins. wide, 22-ins. long and an eighth of an inch in depth. Rough and finish cuts are made in 17 minutes time. Profiling machines are used for intricate cuts, one arm following a master gage and controlling another holding the cutting tool.



Gas-fired Rotary Retort Type Furnaces for Blueing Parts.

BLUEING of gun parts is accomplished in rotary gas furnaces, of which there are a large number, each consisting of a circular steel drum enclosing a revolving retort, the space between the two being utilized as a heating chamber. Gas burners, located in the outer shell, fire into this chamber. The temperatures are controlled by the aid of indicating pyrometers with multiple point switchboards. Special holding racks, each designed for some part, are filled and then slipped into the retorts which in turn are filled with ground bone charcoal.

The parts are heated and soaked in a temperature of 650° F. for from 5 to 6 hours after which the work is removed and allowed to air cool. Some parts require a black, instead of a blue finish, and these are heated to 1000° F. for 4 hours in bone charcoal after which they are quenched in oil.

The heat-treating department is housed in an immense room containing a large number of furnaces, lead pots, salt baths, etc., the bulk of which are fired with gas. These units are equipped with thermocouples and indicating pyrometers with multiple switchboards. Quench tanks are provided wherever necessary. In one end of the room is a line of double brick furnaces which are used interchangeably for various heat treatments, among which is "color hardening."

This is accomplished by a process similar to carbonizing and quite like the practice used for blueing. The colors obtained, however, are more numerous and include gray, yellow drab, blue and brick red. The parts to be colored are packed in boxes in burned bone charcoal, charged into the furnaces and heated to 1400° F., just above the critical, for from one to three hours according to the color desired. While a hard case is not required in work of this sort, carbon penetration nevertheless occurs, but to a somewhat lesser degree than in straight carbonizing where a higher temperature is used.

The main springs are here formed from steel blanks of

a special analysis the closest approach to which is the S. A. E. No. 1095, this latter steel having less manganese and carbon. These blanks are heated to 1420-1430° F., formed and quenched for hardness and then drawn to 750° F. in oil.

Pack hardening large blanking dies, broaches, tools, etc., of high speed tool steel is accomplished in large brick furnaces 8 ft. in length and 6 ft. square. The work is packed in bone and charcoal and charged into the furnace which has been previously heated up to 2240° F. When the work has been brought up to this temperature, it is either quenched in oil, at room temperature, or in lead at 700-800° F. If a specially hard tool is desired the lead quench is used and this prevents checking and reduces distortion.

Smaller parts of high speed tool steel are hardened in a row of five smaller furnaces. These parts are first preheated to 1500° F. in one furnace and then transferred to another and heated to 2300-2400° F. Quenching is done either in oil at room temperature or lead at 700-800° F. They are then drawn at 1050-1120° F., the parts being held at these temperatures for from two to three hours.

Hardening gun parts in lavite baths is here accomplished with less distortion than in lead baths because of slower heating. The lavite adheres to the part immersed in it and liberates the heat to it at approximately the rate at which it is able to receive it. This process is particularly useful for parts of intricate design, to prevent the smaller sections from becoming overheated while the larger are being brought up to temperature. Furthermore the adhering salt prevents oxidation in the air while the part is being transferred from the bath to the quench.

Brazing the front site block onto pistol barrels is performed in a unique manner at this plant. The block is first pressed into a groove on the barrel and the brazing material, in the form of a wire, wound around the joint. The barrels are next strung on rods and put into long steel tubes which are then filled with bone charcoal and sealed at both ends. These tubes are charged into one of a battery of brick furnaces provided for this work, and brought up to the required heat, which usually requires an hour. The operator knows when this heat has been reached by observing the characteristic copper flame (blue-green color.)

This method of brazing was developed at the Colt's plant and results are obtained with it which have never been exceeded by any other process. In fact, rejects were reduced to a tenth of one per cent and excess material is eliminated, which does away with subsequent machining operations. A considerable number of cyanide and nitrate baths are also used in heat treating.

The Value of Armour

"THE value of armour may seem to be obvious. It is true that the soldier realizes that it is a means of protection against blows and missiles, but it is quite exceptional that he relates its protective power to the various types of blows and missiles which are aimed at him. The sailor, seeing that warships have now been armoured for over two generations understands it better, and yet a few years ago it was so vaguely understood that a prolonged discussion arose over the value of the battleships.

"The battleship is valuable, not because she cannot be sunk by gunfire, but because she can only be sunk by the heaviest ordnance. For sake of argument, I will suppose that within effective range only guns of 12-inch calibre and upwards can sink a fully armored ship, then, conversely, all guns of less calibre within this range are unable to sink her, consequently the true value of armour lies not in keeping out all projectiles but only a number of projectiles. If the battleship abandoned all armour, then she could be riddled by a machine-gun. It is because of her armour that she is so powerful, and being protected against all lesser projectiles, she is superior to all craft less heavily armoured, and can fight her like on equal terms. Thus it happens that she is not only a valuable naval unit, but the essential unit, and this is why sailors are logically right in thinking in terms of battleships, and in pivoting the whole of naval tactics on this most heavily armoured vessel.

"On land, it will one day be the same; but that day is still far distant, because soldiers, at least the bulk of them, argue this wise. They say: 'It is true that tank armour will keep out the bullet, but it is not true that it will keep out the shell, therefore tank armour is valueless, for all that is necessary is to equip infantry with a suitable antitank gun, and the tank is then defeated.'

"Here, once again we have the infantry idea intruding itself, and all logic vanishes. Those who pin their faith on antitank weapons cannot see that if tank armour can only cut out the bullet, the greatest killer yet devised by man has itself been killed, and all our tactics must be changed. These people do not, however, carry their argument to its logical conclusion, which is: If the tank is useless because of the antitank projectile, then the infantryman is useless because of the anti-infantry projectile—the ordinary bullet we know today. No—they say: Let us render the tank useless, then the infantryman will come back into his own! The logical conclusion of which is that, as they suggest no alternative, the next war is to be like the last war, with this possible difference, that when it ends we shall be paying twenty shillings in the pound income tax in place of four.

"That this is the focal idea of our present tactics there can be no doubt, and the doubter can convince himself that this is so by visiting any training ground. What will he see? Flags which represent antitank weapons, and what are they for? To protect infantry against tanks? Again the infantry idea—not to protect tanks against their like, but infantry against these machines.

"Place this argument on a naval footing, and we arrive at the following absurdity. A battleship can destroy an unarmoured cruiser, therefore this cruiser must be equipped with a weapon which will destroy a battleship. Obviously she will still be at an enormous disadvantage, because, though the cruiser is now equipped with a special antibattleship weapon, yet none of her other weapons are effective, whilst all the battleship's weapons can equally well sink the cruiser.

"It is not because tank can eat tank, or gun can slay tank, that the tank is going to become obsolete—the reverse. It is because of these things that infantry are going to take a back seat, for these weapons prove that tank armour has defeated the infantry bullet. The infantry antitank weapon is, therefore, the most certain proof that the infantryman's number is up."—Brigadier J. F. C. Fuller in *The Army, Navy and Air Force Gazette*, November 28, 1929.

ARMY ORDNANCE

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Month by Month

THROUGH the coöperation of Mr. Vernon Howe Bailey, ARMY ORDNANCE is fortunate in being able to begin with this issue a series of front cover designs from the hand of that well-known artist. The drawing used for this issue is titled "Forging Ingots for Big Guns" and is one of a number by Mr. Bailey executed during the World War. Upon the entrance of our country into war Mr. Bailey was the first artist authorized by the Government to make drawings of our munitions plants, navy yards, gun shops and other centers of war work. His work was begun at the Naval Gun Factory at Washington, D. C. By special permission of the Secretaries of War and Navy, he visited the navy yards at Brooklyn, Philadelphia and Norfolk as well as private plants including the Curtiss aircraft plant at Buffalo and the flying field at Mineola. He was the only artist permitted to visit the American Fleet before it sailed to join the British forces in the North Sea.

Our Front Cover

Mr. Bailey's series of about eighty war-time drawings were exhibited in leading museums and were extensively published in the current magazines. Later they were purchased and presented to the National Museum of Art of the Smithsonian Institution. Lithographic prints of many of them are in the French War Museum in Paris.

Mr. Bailey's principal subjects, in addition to his war series, have been of American cities and picturesque towns of Europe as well as the great industries of America. He has been honored by a decree of thanks issued by his Majesty Alfonso XIII in recognition of his work in Spain, the King having attended his exhibition in Madrid last year, held under the auspices of the Society of the Friends of Art. Subsequently, he was elected a member of the Royal Academy of Fine Arts of San Fernando, Madrid, in further recognition of his work.

More recently the artist was honored when, during an exhibition of his drawings of Italy, he was received in private audience by Premier Mussolini. This exhibition, held under the auspices of the American Ambassador in Rome, was opened by Count Volpi and Giuseppe Belluzzo, the Minister of Public Instruction, in the galleries of the Italy-America Society in the Salvati Palace.

It is with great pleasure and sincere thanks to Mr. Bailey that ARMY ORDNANCE begins this series of drawings. For the authorization to use the present subject acknowledgment is also made to the National Gallery of Art and to *Harper's Magazine*, the copyright owner.

THE appointment of Col. Patrick Jay Hurley as Secretary of War will meet with general approval because he has the qualifications which will enable him to maintain the Army in that high state of efficiency which is such an essential point in our theory of national defense.

Colonel Hurley, Secretary of War

Native of Indian Territory, ranger, deputy sheriff, attorney, financier and builder, Colonel Hurley began his military career as a captain of cavalry in the Oklahoma National Guard. As such he entered the National Army at the beginning of the World War rising to the grades of major and lieutenant colonel. He participated in the Ainse-Marne, Meuse-Argonne and St. Mihiel offensives. He was awarded the Distinguished Service Medal with this citation: "Lieutenant-colonel, Judge-Advocate General's Department, United States Army. Assigned as judge-advocate, army artillery, First Army, he rendered services of marked ability, performing, in addition to his manifold duties, the duties of adjutant-general and of inspector-general. Later, as judge advocate of the Sixth Army Corps, he ably conducted the negotiations arising between the American Expeditionary Forces and the Grand Duchy of Luxemburg wherein he displayed sound judgment, marked zeal, and keen perception of existing conditions. He has rendered services of material worth to the American Expeditionary Forces."

As in the case of Dwight Davis, Colonel Hurley brings to his new office the experience gained during his services as the Assistant Secretary of War. There one of his principal functions was the administration of industrial preparedness plans. As Secretary, with his broad civilian background, his military service and his intimate knowledge of the industrial aspects of defense, Colonel Hurley embarks upon a term of service which we are confident will be eminently worth while. ARMY ORDNANCE is happy to extend congratulations to the new Secretary of War.

AFTER several months devoted to the breaking-in period of becoming familiar with national defense problems and policies and just as he was beginning to exert a potent, influential leadership, Secretary of War James W. Good died. Tribute to his memory was paid throughout the entire military service wherever American soldiers are stationed in the continental United States and possessions.

Two Leaders Pass On

The late Secretary brought to his important office a long legislative experience. A representative in Congress when America entered the World War, he took a leading part in the framing and passage of the National Defense Act.

In his first annual report on the activities of the War Department, Secretary Good gave evidence of the vision and ability with which the military service would have been guided under his direction. His death prevented the fur-

ther development of that leadership and leaves to others a task which, had he remained, would have brought added renown to himself and efficient military guidance to his country.

In noting the death of Secretary Good we also record the passing of another leader in American public life, Senator Francis E. Warren, of Wyoming, long a member and for many years Chairman of the Senate Committee on Military Affairs. Few men possessed a broader knowledge of, or more sympathetic interest for, adequate national defense. As Chairman of the Appropriations Committee of the Senate he was a powerful factor in defense activities, performing the duties of his office with sound judgment.

In 1862 he enlisted in the 49th Regiment, Massachusetts Volunteer Infantry, and served as private and non-commissioned officer in that organization until it was mustered out of service. Later he became captain in the Massachusetts Militia. He received the Congressional Medal of Honor for gallantry in battle at the siege of Port Hudson. Having served as Governor of Wyoming, he was elected to the U. S. Senate from that state in 1890 and served continuously through seven terms until his death. His was a life of outstanding public service in which the solution of national defense problems was always a matter of real concern. To this veteran of battles—bayonet and debate—America owes a debt of devotion which should keep the memory of him vivid for many years.

Service Pay

A GREAT deal has been said anent proposed legislation for correcting inequalities of pay of the several national defense services. The larger portion by far has been on the score of equalizing service remuneration with that of similar professions and trades in civil life—due allowance being made for the inconveniences, hardships and life-time devotion of those in military and naval service. This is of course a reasonable proposal and is possibly all sufficient if the relief is to be granted on logical grounds. Surely those who devote their lives to the Nation's defense are not to be penalized. It is little enough that they be given a square deal, that they be placed upon a parity with the professional man in the business world.

Even within the services themselves there are gross inequalities of pay which call for prompt remedy. This was strikingly brought out recently by Congressman Fred A. Britten, of Chicago, chairman of the House Committee on Naval Affairs, who is sponsoring the early passage of a joint resolution to investigate pay schedules of the Army, Navy and other defense services of the Government, to correct the general inequalities in the general pay bill of 1922 and to provide for an increase in pay where it is deemed advisable. Mr. Britten cited instances of inequality which "would be funny if their effect were not so serious."

Recalling particular instances in the Navy, Congressman Britten said,

"A rear admiral recently in command of one cruiser, 38 destroyers and two tenders was receiving $6,219 annual pay while two of his lieutenants on one of the tenders each was drawing $6,357 per annum.

"A ridiculous situation was presented when President Hoover went to South America on the battleship *Maryland*. A medical officer aboard with the rank of lieutenant commander and the executive officer, a commander, each were receiving more pay than the captain. It seems incredible that two officers of the same rank, of the same length of service, on the same ship and doing parallel and equally important duties, may receive pay varying as widely as $1,878 because one has dependents and the other has not.

"No one could expect the best results from a large industrial plant where the manager was drawing $6,200 a year while his assistants were getting $1,000 more. Yet that is precisely the situation in the Navy today.

"When the London naval conference has concluded its deliberations, the superiority of a fleet may depend entirely upon the morale and efficiency of the officers and men. All other elements may be practically equal.

"The American will have to shoot faster and hit oftener than the other fellow. His head should be clearer; his mind more active and his training period free from pay annoyances."

Innumerable cases of the same sort might be adduced for the Army, the Marine Corps and others, all of which are ample evidence of the need and justice not only of an equalization of pay within the services but of a general revision to put them on a par with the life and rewards of industrial and professional callings.

As Mr. Britten suggests, after the international conference now in session is over and may we add, after much silly, pacifistic talk has talked itself to exhaustion, the efficiency of our defense services will be found to depend entirely on the morale of officers and men. People of small vision may think a policy of inadequate service pay of little consequence and they will be the very folks to express amazement and dissatisfaction if the day comes with its emergencies which the defense services cannot handle.

Hence, we second most enthusiastically the opinion expressed by the *Seattle Times*:

"The effect of a niggardly policy has been to lower the morale of the services and to encourage highly trained men to seek employment in civil life. If this process were to continue indefinitely we should lose the men whose service is vital to the country's welfare. Congress should lose no time in completing its investigation and in passing the pay bill. The widespread public opinion favoring such a course cannot be disregarded."

Military Mechanization

THE ending of the year and the beginning of another brings forth those barometric indications of the state of the national defense embodied in the annual reports of Army heads. No one source of information emphasizes more accurately the complexity of the Army problem. It is always with a feeling of cautious inquiry that one scans them to determine how items of particular interest are faring. Let's take the matter of mechanizing the Army—head and shoulders the most important development problem before our military authorities now that antiaircraft defense is on so sound a footing. As to the latter, the Ordnance Department under General Williams' leadership has eclipsed all expectations. But mechanization is still in the embryonic stage, the tacticians seem not to know just how to use a mechanized army and they are groping to find machines around which to build their movements.

That mechanization is being given constant study insofar as engineering is concerned is evident from General Williams' annual report, extracts from which are published elsewhere in this journal.

That general progress in this regard is all that it should be is apparent from the statement of the head of the Department. The late Secretary of War, Mr. Good, said in his report, "Studies and experiment were continued throughout the year in the development of types of mechanical equipment and matériel. The proper composition of a mechanized force has not been definitely determined, but each experiment serves to indicate and demonstrate the composition and equipment that should be adopted.

"Our organizational and tactical doctrines have to be constantly considered in the application of mechanics to combat units. When we increase the soldier's mobility we should not accomplish it at the expense of his protection or his striking power.

"Definite progress in mechanization, motorization, and material preparedness is demanded by the nature of modern military power and such progress has been made in the development of tanks and semiautomatic rifles, the importance of which is fully realized."

Reserve Officers Needed

AT the suggestion of Col. James D. Fife, Director, Planning Branch, Office of the Assistant Secretary of War, we join in making known more generally the need for additional reserve officers for assignment to various units in the Procurement Service. This service includes all supply branches of the Army. As is well known to members of the Army Ordnance Association the procurement set-up operates under the general direction of The Assistant Secretary of War, who may be termed the chief purchasing agent, with the entire country covered by local buying and procurement-planning offices. During peace time the personnel of each of these district offices—for the Ordnance Department there are fourteen of them in operation—consists of one or more Regular Army Officers with one or more civilian assistants and a number of reserve officers. The number of men assigned to each office is varied to meet the needs of the market and of the branch of the Army represented. In the event of war the reservists would be ordered to active duty and a war-time purchasing organization for the entire Army would be in action. This would provide a nation-wide decentralized purchasing service. For the Ordnance Department alone 3184 reserve officers are required for its war-time procurement duties of which only some 1222 are assigned; that is, there are some 1900 odd vacancies. For the entire Procurement Service over 6400 officers are required with slightly more than 2600 assigned.

Here is an opportunity for engineers and executives to take stock of themselves and their qualifications. If there is another war each of us will be expected to do for the Nation what we are best able. Supply in the Army is as vital as drill, tactics and all the fanfare. Qualified men should consider it a privilege and honor to be identified with the Procurement Service.

It is not the intention of the War Department to fill all existing vacancies in the procurement sections of the organized reserves at the present time. Appointments will be made gradually by careful selection only, based upon the recommendation of the chief of the supply branch concerned and will be limited to applicants whose experience in the business and industrial world especially qualifies them for service in the procurement of war-time supplies under our industrial mobilization plans.

What—Another Soldier Poet?

LIEUT. Col. Calvin Goddard, Ord. Res., Director of the Scientific Crime Detection Laboratory, Northwestern University, international authority on firearms and the identification of weapons, has responded to the urge of the poetic muse in the following iambic pentameter:

The Flaming Bomb

A Soldier's son was sitting on the fond paternal knee,
When down the street a-marching came a rifle companee;
Oh, Daddy, see the lovely guns, the lad was heard to cry—
I only hope I have a gun like that before I die.

My darling son, my cherished one, the Soldier father said,
You'll have a chance to use a gun like that before you're dead;
You'll be a soldier too some day, and if you're very good,
Perhaps you'll make the Ordnance; I only wish I could.

Now, Daddy, what is Ordnance, and why is it so fine,
And what has it to do with guns, and when do I get mine?
Be patient, son, and I'll explain, as well as e'er I can,
Why Ordnance is so vital to ev'ry fighting man.
(And why the boys on whose lapels the flaming bomb you see
Distinguish any martial throng, no matter where they be!)

You see, my dear, the Army fights with certain special tools
Like mines and bombs and bayonets, and cartridges, and mules,
And shells of high explosive type, and guns both great and small,
And, 'ceptin' possibly the mules, the Ordnance makes 'em all!

But now it seems it won't be long before the mules as well
Will be replaced by motorized ordnance matériel.
They'll tractorize the guns around and give the weary Yanks
A chance to rest their aching dogs by riding them in tanks.

The sabres that the Cavalry which our fair land protects
Employ to cleave the hostile head wherever it projects,
Are Ordnance made, as likewise are the pistols that they use,
And the artill'ry's guns and shells, from bourrelet to fuze.

The old canteen that did supply the store of Adam's ale
Which made the Doughboy do or die where weaker hearts would quail,
Was fashioned in the Ordnance shops, in such superior style
It never could corrode from hooch or other poison vile!

The Engineers use scores of things the Ordnance laddies make.
The Signal Corps and Medicos their bounty do partake:
The Air Men, and the dear M.P.'s, the Quartermaster too,
And ev'ry other mother's son who wears the Army blue.

And so my boy, when you attain discretionary age
And choose a soldier's life to live, and war on War to wage,
Perhaps you'll make the Ordnance, if you're very, very good;
I'd like to wear the bomb myself, I only wish I could.

Clothed in the new mantle of bard, Goddard bids fair for the title of ordnance poet laureate, and ARMY ORDNANCE is faced with the possibility, should the fever become contagious, of beginning a poetry page. Thus from discussion of yaw, trajectory, pitch of rifling, muzzle velocity, track suspension and kindred "deep stuff," this scientific journal may succumb to vers libre. Honestly, we hope not. We have been called "practical, realistic and hard-boiled" and poetry, strictly speaking, is not the language of reality. Goddard better watch his step, too, or he may be lecturing policemen and testifying in criminal proceedings with a racket of his own—rhyme.

The Strategy of Critical War Materials

An Editorial

THE war of words on a war of weapons wages anon and the old stand-patters who fail to distinguish much difference between humanity in 1930 as against the genus homo in plus or minus 930 stand pat! The necessity for national defense won't be talked down no matter how praiseworthy international discussion, conference or agreement. While every post-war period has had its believers that human kind is rid forever of the scourge of armed conflict none, it seems, has evidenced the kind and quantity of talk, sincere and insincere, that has followed the World War. This may be easily accounted for since the biggest scrap called for the most forethought—which it didn't get—and the most afterthought which it is getting now in tremendous barrage.

Of the many panaceas proposed to end war, the plan of Mr. Edward N. Hurley as published elsewhere in these pages, is probably the most novel of them all. We have heard words, words, words, about covenants, treaties, pacts, limitations and, we might add, reparations, but none in our opinion has quite the naive simplicity of Mr. Hurley's well-meaning proposal. It will be recalled that he would prevent war by denying to belligerents a supply of essential raw materials. The machinery for effecting this denial would be, according to the Hurley plan, no machinery at all—it would be simply a *carte blanche* agreement between those in control of essential commodities that they "would not sell them to any actual or prospective belligerent." Believing, as all sincere proponents of peace do, and in this classification we include ourselves no less than the author of the Hurley plan, that discussion of every sincere proposition is helpful to a better understanding of any problem, we address ourselves to this latest remedy to weigh its worth and assay its merit. The simplicity of the proposition warrants simplicity of rebuttal.

STRATEGIC raw materials, so far as America is concerned, are in number just two baker's dozens. They are antimony, camphor, chromium, coconut charcoal, coffee, cattle hides, iodine, jute, manganese ore, manila fiber, mica, nickel, nitrates, opium, platinum, quicksilver, quinine, rubber, shellac, silk, sisal, strychnine, sugar, tin, tungsten and wool. Obviously, the degree of criticality varies. Without delving into the many war-time uses of each and granting the necessity for all, we should say, for instance, that the supply of jute is not quite as essential to the successful prosecution of war as, let us say, the supply of manganese or platinum. Anyway let us concede equal priority to all for discussion's sake. Take the case of lowly jute—not that hardy German stock, warriors they were, who from their native Jutland established themselves at Kent in the British Isles during the fifth century—but jute, the glossy fiber of the East Indian plant used principally for sacking, burlap and the cheaper varieties of twine. Jute is essential and, as we do not know the names of the jute magnates, we are relieved of mentioning them directly as Mr. Hurley has done in respect of some other commodities. Let us assume that the jute magnates, whoever they are, become oral signatories to the gentleman's agreement and thereafter there is no more jute available for "actual or prospective belligerents." Now, to argue the case, we must assume a further condition—and we will be pardoned so absurd a meditation—war occurs or breaks or is thrust upon some nation or other, or just "happens." And more, the native haunts of jute—the homeland of one or more of the jute magnates is of the parties in interest. What then? The jute magnate is torn between two forces—on the one side the need of his native land for the very substance he can supply and with which by so doing maybe save it; on the other the agreement not to furnish jute to a belligerent—and he has given his word to the other jute magnates that all comers are prohibited, his own land as well as every other. Rather a tight predicament but being a man of his word he keeps to the bargain as do the others. And so another war is nipped in the bud. Well now, is it though? And is the whole proposition as simple as that? Even municipalities can take one's building lot for a public highway when the common good requires it. And the larger the subdivision of the state the less the hesitancy in commandeering that which is necessary for its well-being. Somehow or other we imagine that no matter how histerically the jute magnate may wave his "gentlemen's agreement" his own brethern in numbers would go upon his fields and enter his factories and see to it that business goes on as usual to supply their needs for self preservation.

MR. HURLEY has mentioned the individuals who control the world supplies of materials more essential than jute. That they have tremendous influence is not to be denied, but one is doubtful that even they—individually or collectively—can stop the forces of irate peoples who believe their rights to be infracted. We seem to remember that it was freely said not many years back that if Baron de Rothschild in England vetoed war it could not go on merely—it could not begin. And again in our own country it was said that without the sanction of the bankers America could not prosecute war. Yet, if memory serves correctly, neither factor was much of a deterrent when war came. Indeed not only gentlemen's agreements but even more formal pledges were passed lightly over. Appreciating the excellent motive behind the Hurley plan and wishing most fervently that it were feasible of performance, we can only measure it by the gauge of practical experience with which, in our opinion, it does not fit. Meanwhile we must turn to the laboratory to find a substitute for jute and the other members of the critical materials' family in the candid belief that if war comes again science and organization will have found the way even to circumvent the use of many presumably essential substances whether their controlling minds have agreed among themselves about it or not. After all, war and its counterpart, peace, are not things subject to bargain and sale or to agreements not to bargain and sell. They are founded respectively on wrong and its counterpart, right. And if wrong is perpetrated or the right transgressed the common, inherent instinct of the people will assert itself eventually and with adequate force—jute or no jute.

Professional Notes

Ordnance Advisory Committee, S. A. E., Discusses Tank Design

THE Ordnance Advisory Committee, appointed by the Society of Automotive Engineers to coöperate with the Ordnance Department of the Army in the development of automotive weapons, held its 21st semiannual meeting in New York City on November 18th, 19th and 20th, 1929. The following committee members were present:

Lt. Col. A. F. Masury, Chairman; Vice Pres. and Chief Eng., Mack Truck Co.; Mr. P. E. Holt, Vice Pres., Caterpillar Tractor Company; Lt. Col. William Turnbull, Chief Eng., Caterpillar Tractor Co.; Col. Wm. G. Wall, Consulting Engineer, Indianapolis; Maj. Emil F. Norelius, Chief Eng., Allis-Chalmers Corp.; Maj. A. W. Herrington, Gen. Manager, Coleman Motors Co.; Mr. Floyd C. Hecox, Engineer, Cadillac Motor Co.; Mr. Arthur J. Scaife, Chief Eng., White Motor Co.; and Mr. J. F. Winchester, Manager, Automotive Equipment, Standard Oil Co. (N. J.)

In addition, the following were in attendance: Mr. C. F. Clarkson, Secretary, S. A. E.; Brig. Gen. F. H. Pope, U. S. A., Assistant Quartermaster General and Chief, Transportation Service, Q. M. C.; Lt. Col. B. Taylor, Q. M. C., U. S. A., Chief, Motor Transport Div., Q. M. G. Office; and the following personnel of the Ordnance Department, U. S. Army: Col. E. D. Bricker, Chief, Technical Staff; Maj. C. G. Mettler, Exec. Asst. to the Chief of the Manufacturing Service; Maj. W. P. Boatwright, Chief, Artillery Division, Manufacturing Service; Maj. A. W. Ford, Chief, Artillery Division, Technical Staff; Maj. L. H. Campbell, Jr., Chief, Automotive Section, Artillery Division; Maj. P. R. Faymonville, Executive Assistant, New York District Office; Maj. A. S. Buyers, Chief, Automotive Testing Division, Aberdeen Proving Ground; Capt. John K. Christmas, Automotive Section, Artillery Division; and Messrs. H. A. Knox, and W. F. Beasley, automotive engineers, Office, Chief of Ordnance.

The first two days of the meeting were devoted to inspection trips to the plants of the Standard Oil Development Company, Elizabeth, N. J.; The U. S. Wheel Track Layer Corporation, Rahway, N. J. (builders of the Christie-type vehicles); and the Mack Truck plants at Plainfield, N. J., New Brunswick, N. J., and Allentown, Pa. The whole party was taken to the various plants in one of the very latest and most luxurious Mack busses provided by Col. Masury and the Mack Truck Company. The inspection trips were made particularly pleasant and profitable by the system of dividing the party into small groups each conducted through the plant by engineers thoroughly familiar with the work.

The formal meeting of the Committee was held at the Engineering Society's Building at 29 West 39th St., New York City on November 20th, where the Committee was welcomed by Mr. Clarkson, the Secretary of the S. A. E. The meeting was presided over by the Chairman, Colonel Masury, who first brought up for discussion the various vehicles now under development by the Automotive Section of the Ordnance Department.

The committee had presented to it the drawings and photographs of the Light Tank, T1E2, and gave its indorsement to this design as a significant advance in track-laying vehicles, being particularly impressed with its high speed (18 miles per hour), its new and simple "link" suspension which gives a steady gun platform and the longer life of the track and suspension mechanisms. This form of track and suspension has already in endurance test exceeded 2,000 miles.

The committee also examined the general layout drawings of the new 15-ton medium tank and expressed approval of the general design which follows largely that of the light tank, T1E2. The committee approved that feature of both vehicles, whereby the engine is placed in the normal position, that is in the front of the vehicle. The suggestion that the engine be placed in the rear, which has some advocates, was discussed by the committee and the members without exception were unfavorable to this location for a vehicle of this size and type.

Considerable discussion took place in the committee on the general subject of the necessity for the American Army keeping up with the principal foreign powers in the mechanization of its army, the general feeling being, that while the quality of our military automotive equipment compares favorably with that of the British, who are leaders in mechanization, the rate at which we are mechanizing and motorizing our service is rather slow.

During the discussion several members of the committee expressed approval of the design emphasizing particularly the suspension. The automotive engineering staff of the Ordnance Department was praised for its foresight in producing a vehicle of this type.

Without going into further details of the various vehicles and problems taken up at the meeting it is worth noting that the most valuable feature of these meetings is the personal contact and exchange of ideas which takes place between the members of the committee and the representatives of the Chief of Ordnance during the informal part of these meetings. The Ordnance Department personnel are thus apprised of the very latest developments and activities in the automotive industry, which is represented on the committee by leading engineers in the passenger car, truck and tractor field. In this connection it is desired here to express the appreciation of the Ordnance Department, and the Army as a whole, to these men for their unselfish service to the Nation, not only in attending these meetings and arranging the activities in connection therewith, but also because of the frequent advice and assistance which they informally render the Ordnance Department from day to day as occasions arise. Many members of the committee have been assisting the Ordnance Department ever since this committee, due to the foresight of Maj. Gen. C. C. Williams, the Chief of Ordnance, was first organized ten years ago. The assistance of the committee assures that the automotive development of the Ordnance Department is at all times abreast of the latest progress in the great American automotive industry and that there is a resultant coöperation which would be of priceless benefit to our country in a national emergency.

Improved Compositions for Pyrotechnic Signals

THE successful use and rapid development of pyrotechnic signals during the World War formed the basis of an Ordnance Department policy which included a study of the designs in use, simplification and standardization of these, and the development of new and improved designs and compositions.

Much of this work has been done at Picatinny Arsenal where studies of tracers and flares have been made. As the latter may involve the use of parachutes or be projected from pistols and rifles, a variety of requirements is involved.

Pyrotechnic compositions are mechanical mixtures of finely divided chemicals and are similar to black powder with respect to structure and mode of function. While historically older than gunpowder, their development previous to the World War was due to makers of fire works. Military requirements resulted in the rapid development of the art during the war, but this development was, as previously, due to the use of empirical or "cut and try" methods.

Such methods are frequently satisfactory when quick production is necessary to meet a vital need, but further development must depend on systematic research. The period in the development of pyrotechnic compositions has arrived when other than empirical methods are necessary to determine the factors which control intensity and purity of color, stability in storage, and sensitivity to mechanical influences. This method of attack has been employed at Picatinny Arsenal and it may be said that the development of pyrotechnic compositions is being carried out on a much more scientific basis than formerly.

The major considerations involved in the standardization and development of these compositions are economic, chemical, and physical, and a brief discussion of these will be given.

All chemicals used should be nonstrategic, not too costly, and available in large quantities in an emergency. In some cases it has been possible actually to improve compositions when making changes to meet these requirements. An illustration of this is the substitution of asphalt for shellac; this cheaper material, of large domestic supply, being a better fuel and binding agent and also acting as a waterproofing agent.

Chemical stability during storage even under adverse conditions is important. A composition which gives excellent results when first made, but changes during storage is considered unsatisfactory. It has been found that metallic magnesium oxidizes or hydrates when in contact with active oxidizing agents or not completely protected from air and moisture; the inert products causing the composition to become insensitive. Certain compounds volatilize when the temperature is increased, so that segregation or loss of such materials will take place in hot climate storage.

Recognizing that the functioning of a pyrotechnic composition represents a rapid series of chemical reactions (chiefly combustion) at a high temperature, care must be exercised to use no mixtures which slowly react at low temperatures.

To obtain optimum physical effects, the reacting mass should be chemically balanced. As a fairly large number of compounds are used in certain instances, this is not a matter of simple calculation, laboratory work being necessary in such cases.

The chemicals used may be classified as (1) oxygen carriers, (2) fuels, or reducing compounds, (3) flame-coloring agents, and (4) high-temperature flame producers. In some cases a certain material will act in several of these ways. For instance, aluminum is a fuel which gives a very high temperature flame, but the color of the flame is such that the amount permissible is relatively small. Nitrates, chlorates, perchlorates, and peroxides are used as oxygen-carriers. Asphalt, shellac, aluminum, and magnesium serve as fuels. The choice of flame-coloring agents is dependent on the color desired, since it is necessary that one of the elements in the compound used give bands and lines in the desired part of the spectrum. Thus barium compounds give green and strontium compounds red flames respectively.

It has been found advantageous if the oxidizing agent contain the color-producing element and be of such nature that, on dissociation, volatile compounds are formed rather than refractory oxides. For the production of a white light, a continuous band of radiation from the red to the violet in the spectrum is necessary. Metallic aluminum or magnesium will give this. It should be noted that at the present time the Ordnance Department is interested in only red, green, and white flares because signals of other colors lack distinctiveness under certain conditions of the atmosphere.

Physical factors must be taken into consideration. The rate of burning of the composition must be within a given range. Its sensitivity to shock or friction should be low, while it must be easily ignited. It should be not more than slightly hygroscopic. The color of the flame must be definite, and the candlepower as high as possible so as to insure maximum visibility.

Certain of these factors are of more than general importance. Mixtures with too rapid burning rates may detonate. While chlorate compositions will withstand the shock of discharge from pistol or rifle, there is danger of explosion in the gun barrel when projected from weapons of larger caliber. Hygroscopic mixtures become less sensitive to ignition.

Laboratory work in pyrotechnic research involves the determination of these physical characteristics, and the necessary methods have been standardized. These include the impact and pendulum friction tests, photometric determination of candlepower, pyrometric measurement of flame temperature, ignition temperature test, hygroscopicity test, spectrographic analysis of the flame, etc.

Colored smokes are considered to be pyrotechnic compositions. They are produced by volatilizing colored compounds which may be either organic or inorganic. Arsenic disulphide and organic dyes are used. The volatilization is accomplished by the smothered combustion of a mixture of an oxidizing agent and a fuel in which is incorporated the so-called "colored compound." Typical white, red and green flare compositions are: white—Ba $(NO_3)_2$, 75 per cent; Al, 18 per cent; S. 5 per cent; linseed oil, 2 per cent; red—$KClO_3$, 83 per cent; $SrCO_3$, 11 per cent; Asphaltum, 6 per cent; green—Ba $(ClO_3)_2$. H_2O, 87.5 per cent; Al, 2.5 per cent; Asphaltum, 10 per cent.

G. J. SCHLADT,
Pyro Engineer, Picatinny Arsenal.

Joint Army-Navy Defense Tests

THE Secretary of War and Secretary of Navy have recently issued instructions that five minor joint Army and Navy exercises be conducted according to the following schedule.

Place	Time	Naval Forces Participating
Panama	Feb. 25-Mar. 10.	Battle Fleet
Philippines	To be arranged by Army and Navy commanders concerned.	Asiatic Fleet
Hawaii	To be arranged by Army and Navy commanders concerned.	Naval Forces based on Pearl Harbor
Harbor Defenses of Long Island Sound	May, 1930.	Scouting Fleet
Harbor Defenses of San Francisco	July, 1930.	Battle Fleet

The Commanding Generals of the Panama Canal, Philippine and Hawaiian Departments, and the First and Ninth Corps Areas, Major Generals Malin Craig, Douglas MacArthur, Fox Conner, Preston Brown and John L. Hines, respectively, will arrange for these exercises with the naval commanders concerned. They will be drawn up with a view to testing existing defense projects and plans, to solving the problems presented in the coördination of the action of air, antiaircraft and harbor defense forces of the Army in the defense against the elements of an attacking fleet; to improving the tactics and technique of the defense arms; and, to developing efficient communication and teamwork among all the elements of the defending forces. In addition, they will afford an opportunity to develop efficient communication and coöperation between harbor defense forces and the naval patrols of these forces which are furnished by the naval districts.

The exercises will continue day and night, actual war conditions being simulated as far as practicable. Posts will be darkened at night so that they will not offer a good target for the naval forces. Simulated air combats between the two air forces will occur.

Aerial Photograph of 2,200 Square Miles Completed

AFTER four months' work, the greater part of this time being spent in vigilance for absolutely clear days, an aerial photograph of 2,200 square miles of the west coast of the southern peninsula of Michigan has been completed by an Army Air Corps expedition. The counties include Muskegon, Oceana, Mason, and part of Lake County.

Figuring the cost of the operation of the plane during photography and in preparation therefor at the rate of $90.35 per hour and including the personal expenses of the members of the expedition and the cost of photographic material the cost of the mission was $13,864.84 or about $6.30 per square mile. This included six prints of each of the 3,357 negatives exposed, for the use of the United States Geodetic Survey in their preparation of maps of this part of Michigan.

Air Corps officers who have flown over parts of the area photographed and who are familiar with this type of country estimated that the cost of $6.30 per square mile for aerial photography was considerably less than that required to feed one man during the ground mapping of a square mile of some of the territory.

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Patents

THE following is a resumé of recent Ordnance Patents compiled by Mr. W. N. Roach, Chief, Patent Section Office of the Chief of Ordnance, War Department:

AMMUNITION

Maj. Harold M. Brayton, Spec. Res., Picatinny Arsenal, has been granted Patent No. 1,719,359, for a combination fuze and bomb. The patent relates to a fuze which may be set for instantaneous action or for delay action of varying lengths, a single firing pin being used to initiate the detonation of the fuze.

Patent No. 1,723,315 to Alfred F. Teitscheid, Picatinny Arsenal, for a fuze for projectiles which relates to a combination fuze, the structure of which is such that the elements entering into the formation of the fuze container may be loaded as units and then readily assembled.

Archie F. Nair and Hobart A. Nair, Glendale, Calif., Patent No. 1,723,804 for a gas bomb adapted for discharge from aircraft. The device consists of a gas chamber and an explosive device attached thereto with means for detonating the explosive.

Andre Varaud, Geneva, Switzerland, Patent No. 1,726,325 for a percussion fuze for projectiles which relates to a mechanism having a time train therein actuated by a centrifugally movable rack.

Patent No. 1,727,360 to Walter L. Shively, Pittsburgh, Pa., for a flare. This flare has a signaling means in the form of a colored light to indicate the length of time during which the flare will continue to burn.

Guy A. Rupp, Allentown, Pa., Patent No. 1,729,559, for "ordnance material." The object of this invention is to render containers of explosives safe against explosion through the penetration thereof by bullets or shell fragments. For this purpose the container is lined with a membrane not less than one-quarter of a millimeter in thickness having low heat-conducting capacity and having flexibility, resiliency or compressibility.

Natalino D'Orsaneo, Philadelphia, Pa., Patent No. 1,737,833 for an antiaircraft projectile. The device consists of a tapered shell having longitudinal ducts spaced about its periphery in which bullets are housed, the shell being partially encased in the surrounding envelope containing explosive adapted to propel the shell and the bullets forward after a predetermined period of flight.

ARTILLERY

Arthur T. Dawson, James F. White and George T. Buckham, assignors to Vickers, Ltd., Westminster, England, Patent No. 1,719,597 for a recoil and run-out apparatus for ordnance. In this device the recuperator cylinder and recoil or brake cylinder are arranged in line, one behind the other, and the recoil cylinder or its piston rod constitutes a ram to effect compression of the air within the recuperator during the recoil movement of the gun.

Patent No. 1,721,704 to Giuseppe Madaschi, Milan, Italy,

for an apparatus for throwing bombs or torpedoes. In this device the gun barrel is rifled on the exterior surface; the projectile is formed with the annular recess into which the gun barrel may project and lugs are formed on the rear of the projectile to enter the rifling on the exterior of the barrel. A center tube forming the inner wall of the annular recess extends into the gun barrel and contains a propelling charge in addition to the propelling charge in the gun barrel.

Heinrich Just and Hermann Hort, Essen, Germany, assignors to Fried. Krupp Aktiengesellschaft, Patent No. 1,722,923 for a fire-control apparatus for guns. This apparatus is intended for guns mounted on a rocking platform such as the deck of a ship.

William Q. Kennedy, New York, N. Y., Patent No. 1,723,623 for a self-centered, nonsighted, second-of-time gun. The main object of this invention appears to be to provide a gun that is self-centered and will move automatically so as to maintain the axis of its barrel in the same vertical plane when elevating the gun, regardless of the fact that the platform on which the gun is mounted may be in the nonhorizontal position.

Patent No. 1,724,183 for a mount for guns to August Dabrasky and George W. Beatty, Office of the Chief of Ordnance, Washington, D. C. The main objects of this invention are to maintain a substantially fixed base at all elevations, to reduce the actuating movement below that required on a fixed axis of rotation, to provide the lowest possible mounting for all angular positions of the gun, to fix the point of application of the thrust to the mount and to associate an equilibrator with one of the levers of the system.

Edward J. McCormick, Office of the Chief of Ordnance, Patent No. 1,725,814 for an extracting implement. The main object of this invention is to provide an extractor for removing dummy rounds of ammunition and ruptured cartridge cases in which there is provided an element for positively engaging the round or case which cannot slip from such engagement as has heretofore been the case with extractors.

Patent No. 1,731,863 for an automatic breech opening and closing mechanism for guns to Nicolas E. Methlin, assignor to Schneider & Cie, Paris, France. The main object of this invention is to provide an automatic breech opening and closing mechanism in which the movements for opening the breech, extracting and ejecting the spent cartridge case are completed before the return into battery position of the barrel and in which the whole of the energy required for the movements of opening and closing the breech is drawn exclusively from the return to battery recuperator.

Joseph Dugan, Los Angeles, Calif., Patent No. 1,733,531 for a sight-controlled gunnery system. The patent covers a new system for the automatic control of guns mounted on unstable platforms such as the decks of battleships or the chassis of railroad guns. The main object of the invention is to eliminate completely the inaccurate and costly directorscopes heretofore used in attempts to correct errors in gun training and elevating caused by the rolling and pitching of the gun-supporting deck or platform and to substitute therefor a simple and mathematically accurate means for directing and holding the gun with its axis fixed in space in a predetermined vertical plane and at any desired angle of elevation, regardless of the rolling or pitching of the platform.

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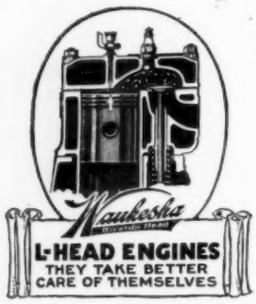

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Books

Our Secret War. By Thomas M. Johnson, Indianapolis: The Bobbs-Merrill Co. 1929. $2.50.

THERE can be no doubt that Thomas Johnson as an accredited correspondent of the *New York Sun* had the opportunity to obtain considerable inside information concerning the activities of the American intelligence organization and many of those who were connected with it. In his years of writing he has perfected himself in unfolding his gripping stories in a most dramatic and intensely vivid style. That part of the Army General Staff dealing, among other things, with the business of secret service, G-2, is in itself a mystery to most Americans. Those who have had their own letters censored, or who have received letters bearing the devastation of the censor, will read with keen interest the numerous stories and incidents which have been collected in this book and will more understandingly appreciate the absolute necessity for such seemingly unnecessary meddling with their private affairs.

The lives of the spy and informer must unfortunately be devoid of public praise and visible glory and the great part these valuable persons play can, for obvious reasons, be disclosed only in withholding their true identities. The author, however, is seemingly unhampered by this restriction and tells of plots and counter-plots, secret codes, and dual lives most fascinatingly. We are assured that the greater part of the book is founded on most authentic information so that we can marvel at and admire without reservations the organization and operators herein depicted in these American spy stories of 1917 to 1919.

Television: Present Methods of Picture Transmission. By H. Horton Sheldon, Ph. D. and Edgar Norman Grise-Wood, M. A. New York: D. Van Nostrand Co., Inc. 1929. $2.75.

THE authors, who are of the faculty of New York University, have produced a timely handbook for the layman who is interested in this very new and highly technical phase of wireless electric communication.

The subject is interestingly opened by an historical survey, beginning with the first method on record: that of Bakewell in 1847. We are then given simple discussions on the basic elements of television in general, in the following chapters: the human eye, electromagnetic waves, the selenium cell, the photoelectric cell, glow lamps, oscillographs, scanning, and synchronization. Having been thus prepared we are ready for the chapters which follow describing in detail specific systems of television: the Baird televisor, the Bell, the Jenkins, and the Alexanderson systems. The book fittingly closes with a discussion of amateur equipment and the future of the art. Apropos of this, the authors say "There is little question but that ten years from now we shall receive television broadcasts as readily as we receive radio programs today."

Men and Machines. By Stuart Chase. Illustrated by W. T. Mench. New York: The Macmillan Co. 1929. $2.50.

MANY books have been written to prove the disintegrating effect of machinery on our civilization. In the majority of cases the authors have apparently had no close personal knowledge of machinery. Mr. Chase knows machines and machine processes. He describes the various forms of machines and their development from Watt to the present time. After showing to how great an extent machinery affects the lives of all of us, he strikes a balance sheet of the good and the evil that derives from actual conditions. It is a brilliant analysis of cause and effect, but there will not be unanimity of opinion in his conclusion on the "two hour war." One recalls too vividly the prediction made by economists, scientists, and soldiers too, of the short duration of the war that started in 1914. It is, however, a striking and unprejudiced commentary on the mechanization of modern life.

Nobel: Dynamite and Peace. By Ragnar Sohlman and Henrik Schuck. Translated by Brian and Beatrix Lunn. New York: Cosmopolitan Book Corporation. 1929.

THE story of the accomplishments of the Nobel family, including especially Alfred Nobel, his brothers Robert and Ludwig, and his father, Immanuel, cannot fail to arouse the reader's interest. Alfred Nobel is well known as the inventor of dynamite, blasting gelatin, detonators, and of the type of smokeless powder known as Ballistite, and also as a staunch advocate of world peace. Few, however, are familiar with the pioneer work of the Nobel brothers in the oil industry, in opening up to world trade the Baku oil fields of Russia and revolutioning the Russion oil industry by the introduction of pipe lines, tank steamers, etc.

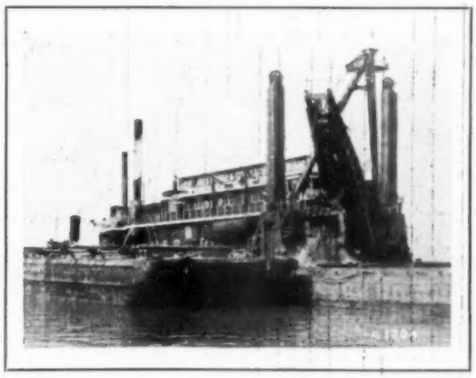
One cannot help but be amazed at the persistent efforts of Alfred Nobel to perfect the manufacture of nitroglycerin and render its use reasonably safe, in the face of repeated disasters, one of which cost the life of his younger brother Emil. The biographical and historical portions of the book are well written and full of interest. Unfortunately the technical portions are marred by numerous errors which cannot fail to catch the eye of the chemist. This fact, however, does not in the least detract from the interesting story told by the authors. The final chapter discusses Nobel's will, which contains his bequest "to those persons who have rendered the greatest services to mankind" in physics, chemistry, medicine, literature, and world peace. One of several appendices contains a list of the Nobel prize winners in each subject.

Conditional Sales. By Roger Sherman Hoar. New York: The Ronald Press Co. 1929. $10.00.

READERS of ARMY ORDNANCE will doubtless recall the contributions made from time to time to our columns, by Major Roger Sherman Hoar, Ord Res., on the two unrelated subjects of Ballistics and Patent Law.

Major Hoar was formerly a Captain of C. A. C., Regular Army, and his war-time assignment is to the Technical Staff at Aberdeen Proving Ground; but in civilian life he is Commercial Attorney of Bucyrus-Erie Company, in which capacity he handles their patent affairs and the legal aspects of the quantatively large, although relatively small, part of their business which is done on the instalment plan.

TITANS OF THE SEA



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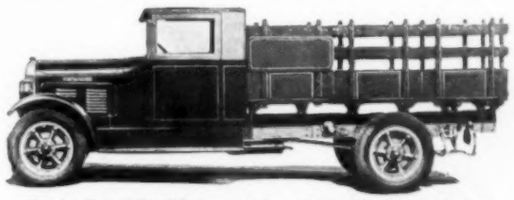

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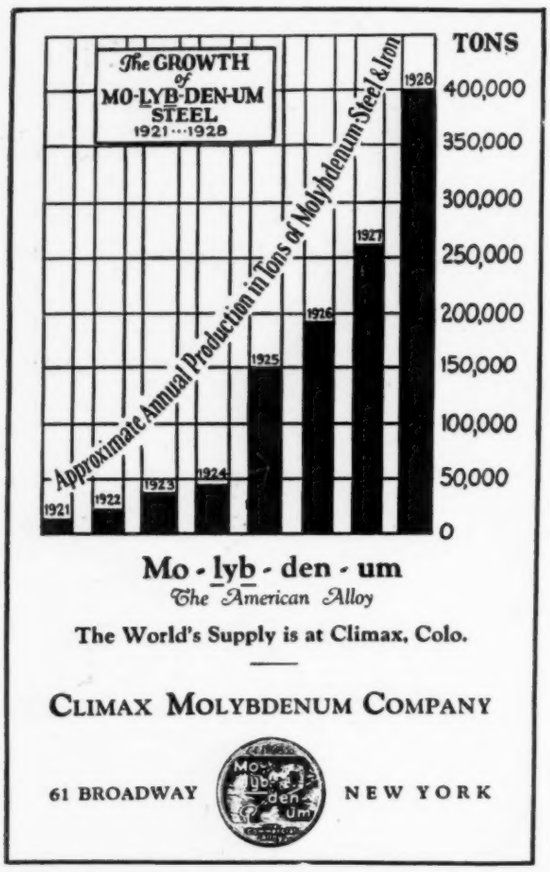

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His book on "What a Business Executive Should Know about Patents," which appeared from the Ronald Press in 1926, and has been kept up-to-date in successive reprintings, has enjoyed such a phenomenal success, that he has now followed it by a treatise on "Conditional Sales," written in the same popular vein, but supplemented by footnotes which set forth the authority for every statement made in the text, thus making the book as valuable for lawyers as it is for executives.

Although there are over six billion dollars worth of instalment credits outstanding, the author estimates that less than 50 percent of all the conditional sales contracts, which secure that credit, would stand the test of a vigorous attack in court.

Major Hoar's book contains many features never before presented, such as the split counties of Alabama, Kentucky, Missouri and Virginia, the status of conditional vendors under the 1910 amendment to the Bankruptcy Act, the far-reaching effect of the Sales Act on conditional sales, the proper procedure when compliance with some recording law is impossible, etc.

Simple Aerodynamics and the Airplane. By Charles N. Monteith. 3rd edition, revised by Colonel C. C. Carter, U. S. A. New York: The Ronald Press Company. 1929. $4.50.

THIS, a book of the Ronald Aeronautic Series, is an improved edition of an excellent basic text on aviation which has been in use at the U. S. Military Academy for five years. The author is a former officer of the Army Air Corps and is now chief engineer of the Boeing Airplane Company. While this work is intended primarily as a text it is so well written and illustrated that it can be recommended readily as a handy reference and general introduction to aviation for the interested layman, the engineer and for military and naval personnel.

This work begins with chapters on the theory of flight leading to the complete airplane and its performance and closes with very complete chapters on airplane equipment and the military airplane. There are 207 excellent illustrations, which add greatly to the interest and clarity of a basic work on so large and complex a subject. There is an amazing amount of real and well arranged information packed into the 400-odd pages without resorting to language or mathematics beyond that of ordinary physics and mechanics.

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